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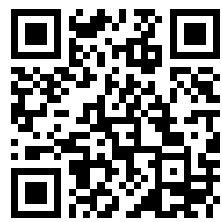

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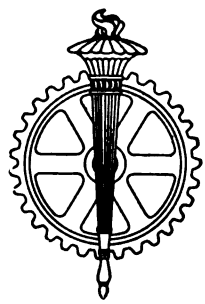
AN INDUSTRIAL REVIEW

VOLUME L

OCTOBER, 1915, TO MARCH, 1916



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THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. L OCTOBER, 1915 No. 1

THE FORESTS OF THE UNITED STATES

By Leonard Lundgren

We talk in a general way about the necessity of conserving our timber lands; few of us know what our resources in timber actually are, and still fewer appreciate the extent to which these resources are being depleted annually both by legitimate lumbering operations and by forest fire devastations. The figures in this article were compiled by Mr. Lundgren from official estimates of the U. S. Forest Service. The view on the cover of this issue shows a forest ranger fighting fire with a saddle blanket in yellow pine timber on the Wallowa National Forest, Oregon.—THE EDITORS.

THE forests of the United States before the coming of the white man covered an area of approximately 800 million acres and contained about 5,200 billion board feet of lumber. Fire has destroyed as much timber as has been utilized for industrial purposes, and as much again has been wasted through poor logging and milling operations and through clearing land for agricultural purposes. Now the forests cover an area of 550 million acres and contain approximately 2,900 billion board feet of lumber. Seventy-six per cent of this, or 2,200 billion board feet, is privately owned and is valued at six billion dollars. Two hundred and thirty-eight billion board feet, or eleven per cent, of the private holdings are owned by the Southern Pacific Railroad, the Northern Pacific Railroad, and the Weyerhæuser Timber Company. About twenty-one per cent, or 600 billion board feet, is held by the United States under public ownership in the National Forests, and three per cent, or 90 billion board feet, is on other public lands, either federal, state, or municipal.

The average stand in the virgin forests several hundred years ago has been estimated at 6,500 board feet per acre; today the average stand is 5,300 board feet per acre, while the stand in the National Forests averages only 3,700 board feet per acre. This low figure for the National Forests is due to the fact that most of the heaviest timber stands had passed to private ownership before the conservation movement became effective.

LOCATION

One-half (1,450 billion board feet) of the standing timber in the United States is located near the Pacific

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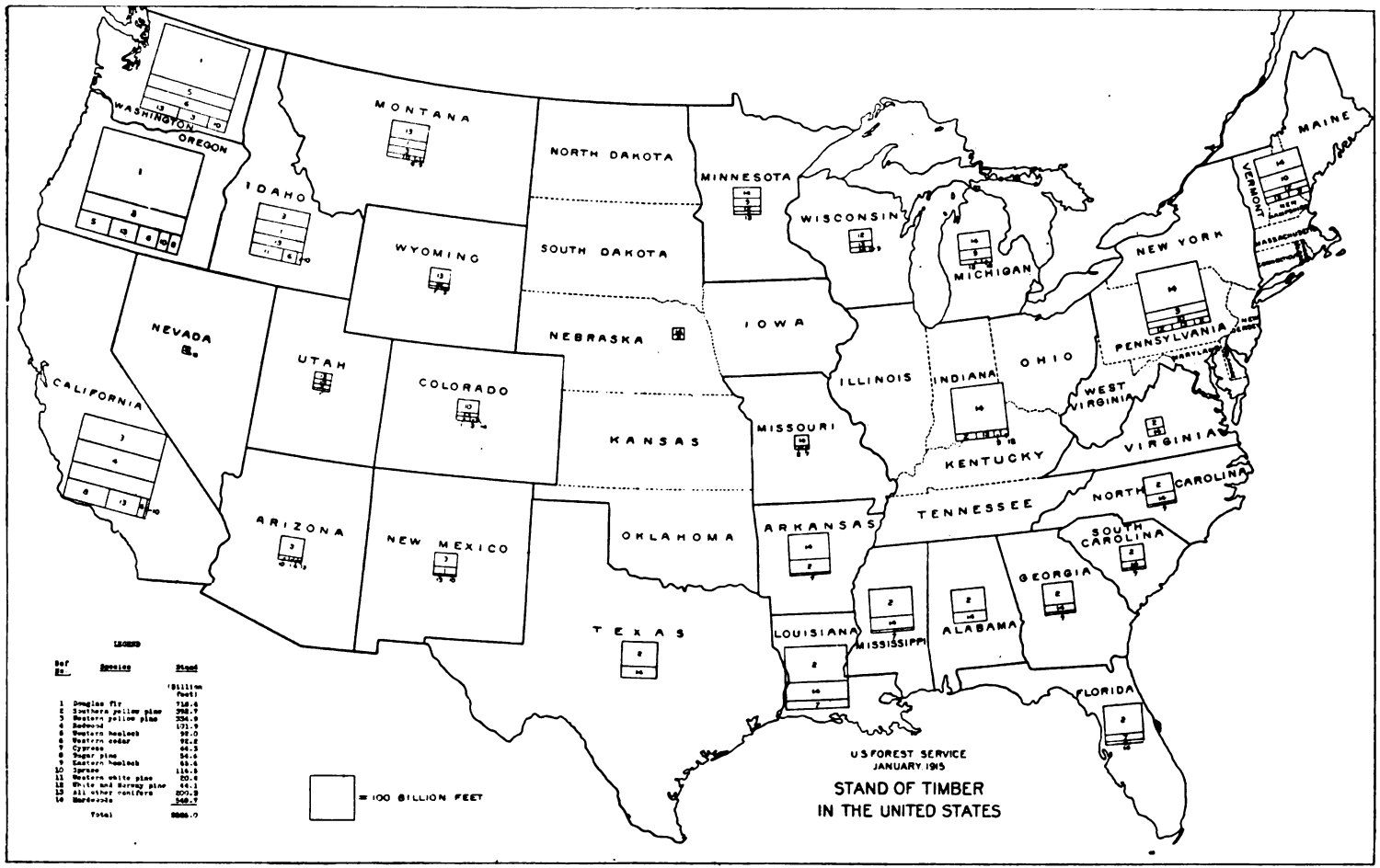

LOCATION AND SPECIES OF STANDING TIMBER IN THE UNITED STATES

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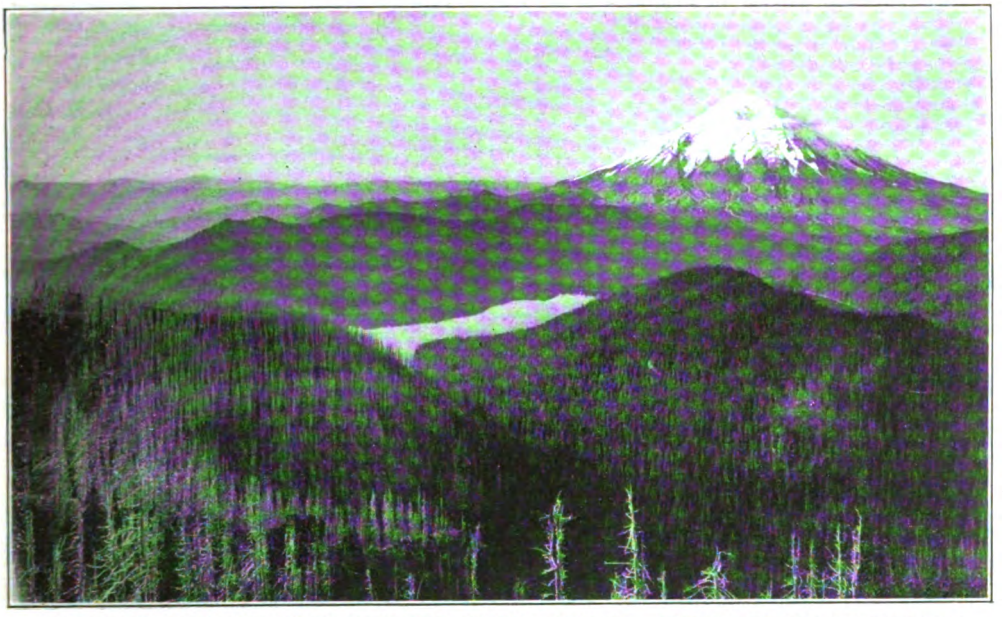

MT. ST. HELENS, COLUMBIA NATIONAL FOREST, OREGON. SPIRIT LAKE IN FOREGROUND

Coast (Washington, Oregon, Idaho, and California), where the chief trees are Douglas fir, western red cedar, western white and yellow pine, western hemlock, sugar pine, western larch, and redwood. About one-fourth (720 billion board feet) is located in the southern pine region (Louisiana, Mississippi, Arkansas, Florida, Texas, Alabama, and parts of Georgia, North Carolina, South Carolina, Virginia, and Missouri), where the principal trees are longleaf, shortleaf and loblolly pine (all marketed under the name of yellow pine), cypress and gum, oak and other hardwoods. The Lake States contain perhaps 100 billion board feet of timber, mostly white, Jack, and Norway pine, hemlock, balsam, birch, beech, and maple. The Northeastern States are the chief source of supply for spruce, which is used largely in the manufacture of paper.

Annual Cut

The annual cut of saw timber in the United States is approximately forty-three billion board feet. At this rate, if there were no new growth and the present demand were maintained, our timber supply would last about sixty-five years. The Pacific Northwest now furnishes only one-sixth of the annual cut, though it contains practically one-half of the standing timber in the United States. The southern pine region is now the center of the lumber industry, supplying about forty-five per cent of the timber consumed. The Lake States supply only a small percentage, although this region, because of cheap transportation to market, was once the center of the lumber trade. In 1913 the chief lumber producing states, in the order of their importance, were: Washington, Louisiana, Mississippi, Oregon, Texas, North Carolina, Arkansas, Alabama, Wisconsin, Virginia, West Virginia, Michigan, California, Minnesota, and Florida. Yellow pine furnishes more than thirty-eight per cent of the lumber used and Douglas fir more than fourteen per cent. Washington supplies the most Douglas fir and west-

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A THOUSAND SHEEP GRAZING IN THE HOLY CROSS NATIONAL FOREST IN THE COLORADO ROCKIES

ern red cedar; Louisiana, the most yellow pine, tupelo, and cypress; Mississippi, the most cottonwood; Arkansas, the most hickory and red gum; Wisconsin, the most basswood, birch, and hemlock; Michigan, the most beech, elm, and maple; Minnesota, the most white pine, and West Virginia the most oak, yellow poplar, and chestnut.

The people of the United States use, in a normal year, about 40 billion board feet of lumber, 90 million cords of firewood, 135 million hewn railroad ties, 30 million sawed railroad ties, 889 million posts, 3½ million telegraph and telephone poles, 1,686 million staves, 136 million sets of heading, 353 million barrel hoops, 3,300,000 cords of pulp wood, 165 million cubic feet of round mine timbers, and 1,250,000 cords of wood for distillation.

The annual growth of wood in the forests of the United States has been estimated to average approximately twelve cubic feet per acre. The annual consumption, considering the present forest area, is thirty-six cubic feet per acre. The forests of the United States are, therefore, being harvested three times as fast as they grow.

Future Supply

Owing to the increase of population it is reasonable to expect that all agricultural lands, cultivated or uncultivated, will ultimately be placed under crops that will give the greatest economic return. Some of the lands that are now being cultivated for food and forage crops will unquestionably revert to forest, while large areas that are now in forest will eventually be cultivated. Forestry experts have estimated that the amount of land devoted to the cultivation of timber will decrease from its present area of 550 million acres to approximately 450 million acres,

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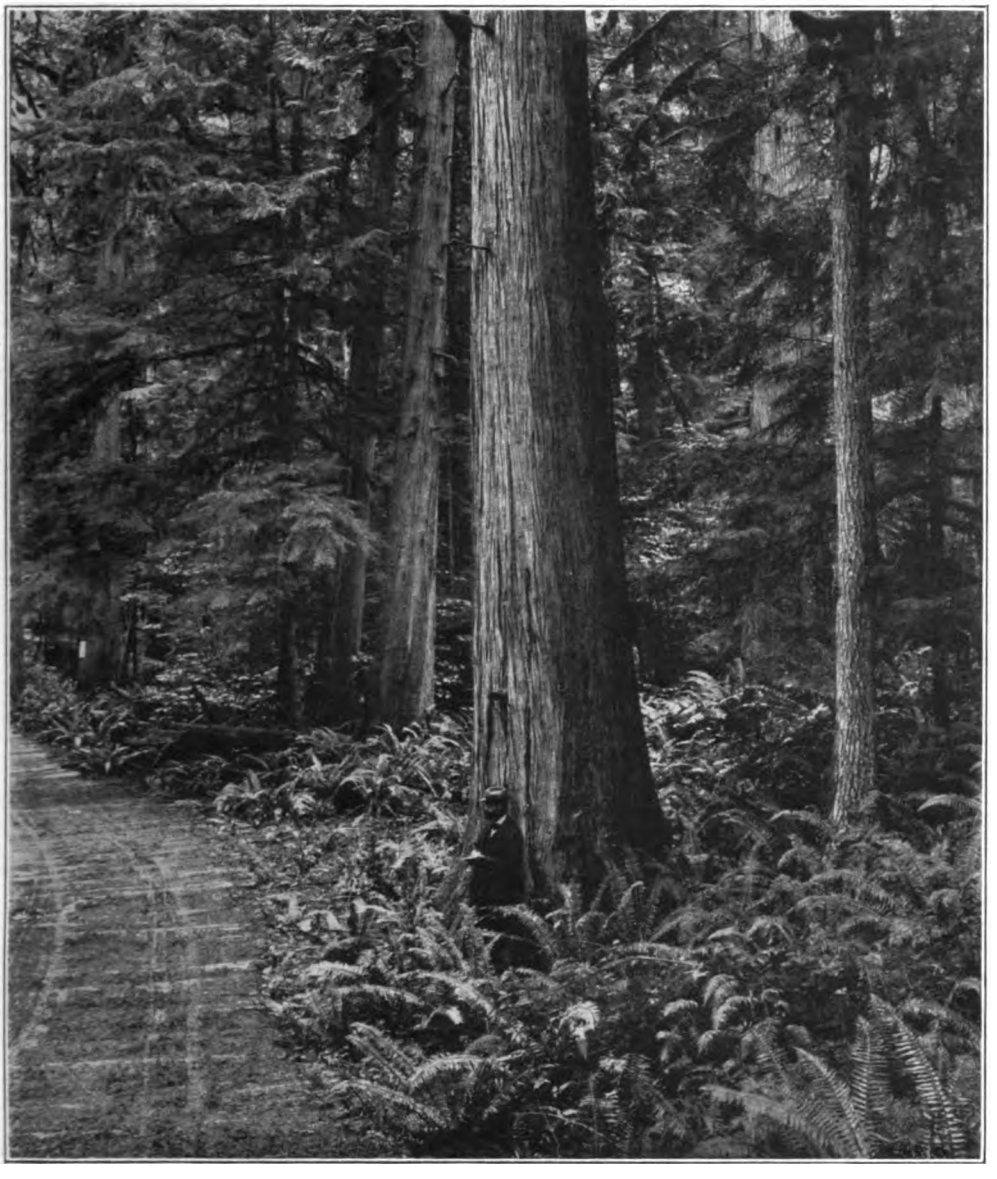

VIRGIN STAND OF RED CEDAR, WASHINGTON. NOTE THE LUXURIANT UNDERGROWTH

or, assuming a population of 150 million, to three acres for every inhabitant. To maintain our present per capita consumption of 260 cubic feet of wood there would have to be over twenty-one acres of land reserved for forest purpose for every inhabitant, or more than seven times the probable future area of forest land in the United States. The present forest area is less than eight acres for every inhabitant. The needs of the people today are supplied because the forests contain a virgin stand of timber which represents the accumulated growth of centuries. For this reason it is difficult for the average person to conceive of the conditions that will exist in the future when our timber crop is harvested in a manner similar

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SISKIYOU NATIONAL FOREST, DEL NORTE COUNTY, CALIFORNIA

to other agricultural crops. In fact, very few people today think of timber as though it were an agricultural crop.

The constantly decreasing area of virgin timber will gradually compel an economical use of wood. As lumber becomes more expensive, the growing of timber as an agricultural crop will become commercially feasible. This has been demonstrated to be true under the existing economic conditions in Germany. Through reducing the per capita consumption, protecting the forests from fire, and increasing the annual growth per acre by the practice of forestry, it is probable that a balance between production and consumption will eventually be reached by the force of natural economic laws. Greater efficiency in the use of wood will materially re-

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duce the annual per capita consumption, which at present is 260 cubic feet. In fact, the use of concrete and fireproofing materials has already effected a reduction in the per capita consumption. Under existing manufacturing conditions only fifty per cent of the volume of the tree is now utilized, leaving half to be wasted. Forest fires destroy, on an average, twelve billion board feet of timber annually in the United States. Scientific fire protection will, without doubt, considerably lower this average, making the quantity saved from fire available for beneficial use. The aim of scientific forestry is to bring the forest up to its highest state of productiveness and keep it there. In the United States, where forestry is not practised except on Government and State lands, and there only during the last few years, the estimated annual production is, as stated previously, twelve cubic feet per acre. In Saxony, where forestry has been practised for many years, the annual production is ninety-three cubic feet per acre. If our final forest area of 450 million acres is made to yield an average of fifty cubic feet per acre, as can be done by the practice of scientific methods, there would be enough wood for a per capita consumption of 150 cubic feet by 150 million people.

NATIONAL FORESTS

LOCATION AND AREA

The public lands of the United States reserved by the Federal Government for forestry purposes are now divided, for administrative purposes, into 153 National Forests. Due to the comparatively recent development of the conservation movement and the fact that the public lands owned by the Federal Government are located principally in the West, most of the National Forests are located in that region. Congress, however, has been appropriating for several years two million dollars annually for the purpose of purchasing lands in the East, in order to protect the navigability of rivers and to distribute more evenly areas reserved for growing forests. There are seventeen National Forests in the State of California, fifteen in Oregon, eleven in Washington, two in Alaska, seven in Nevada, nineteen in Idaho, eleven in Utah, ten in Arizona, seven in New Mexico, seventeen in Montana, eight in Wyoming, seventeen in Colorado, one in North Dakota, three in South Dakota, one in Nebraska, two in Arkansas, one in Oklahoma, two in Minnesota, one in Michigan, and one in Florida. In addition, there are sixteen purchase areas located in the Alleghany Mountains, distributed as follows: two in Georgia, four in North Carolina, five in Virginia, one in West Virginia, three in Tennessee, one in New Hampshire. The total area of National Forest land is 163,000,000 acres, equaling that of the New England States, New York, Pennsylvania, Delaware, Maryland, and Virginia combined. In addition, there are contained within National Forest boundaries approximately 21,000,000 acres that have passed from the control of the Federal Government either to the States or to private interests. The average area of public land reserved in a National Forest is slightly over 1,060,000 acres. The unreserved public lands of the United States totaled 666,000,000 acres in 1914.

PURPOSE

The National Forests are set apart to insure a perpetual supply of timber for the use and necessities of the

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VIEW OF THE CASCADE MOUNTAINS IN THE COLUMBIA NATIONAL FOREST, WASHINGTON

people of the United States, and to prevent avoidable destruction of the forest cover, which is an important factor in regulating the flow of streams. It has been found that on denuded watersheds the stream flow is less uniform than on forested areas, and more rapid erosion of soil takes place. The final results of deforestation are barren mountain sides and flooded and, consequently, devastated lowlands.

Resources

The National Forests contain approximately 600 billion board feet of merchantable timber worth at least one billion dollars. The other resources, such as grazing, water supply, water power, irrigation, etc., are worth probably more than a billion dollars, bringing the total value up to over two billion dollars. At the present time they contain 1,175 watersheds that supply water to as many cities and towns for domestic purposes; 324 water power, and 1,266 irrigation projects developed or in the course of development.

Administration

The Forest Service of the Department of Agriculture administers the National Forests. During 1914 a permanent force of over thirty-seven hundred men was employed to protect these forests from fire and other destructive agencies, to build roads, trails, telephone lines, bridges, and other works to make them accessible; to conduct the sale and oversee the cutting of mature timber in accordance with the principles of forestry; to regulate the grazing of livestock in order to improve the range; to protect the settler and home builder from unfair competition in its use, and to issue permits for the development of its water power resources and for the construction of hotels, dwellings, stores, factories, telephone lines, conduits, public roads, reservoirs, etc. It is the purpose of the Forest Service to encourage the development of the resources of the National Forests. The timber, water, and pasture are used by the people under scientific regulation and mineral land is open

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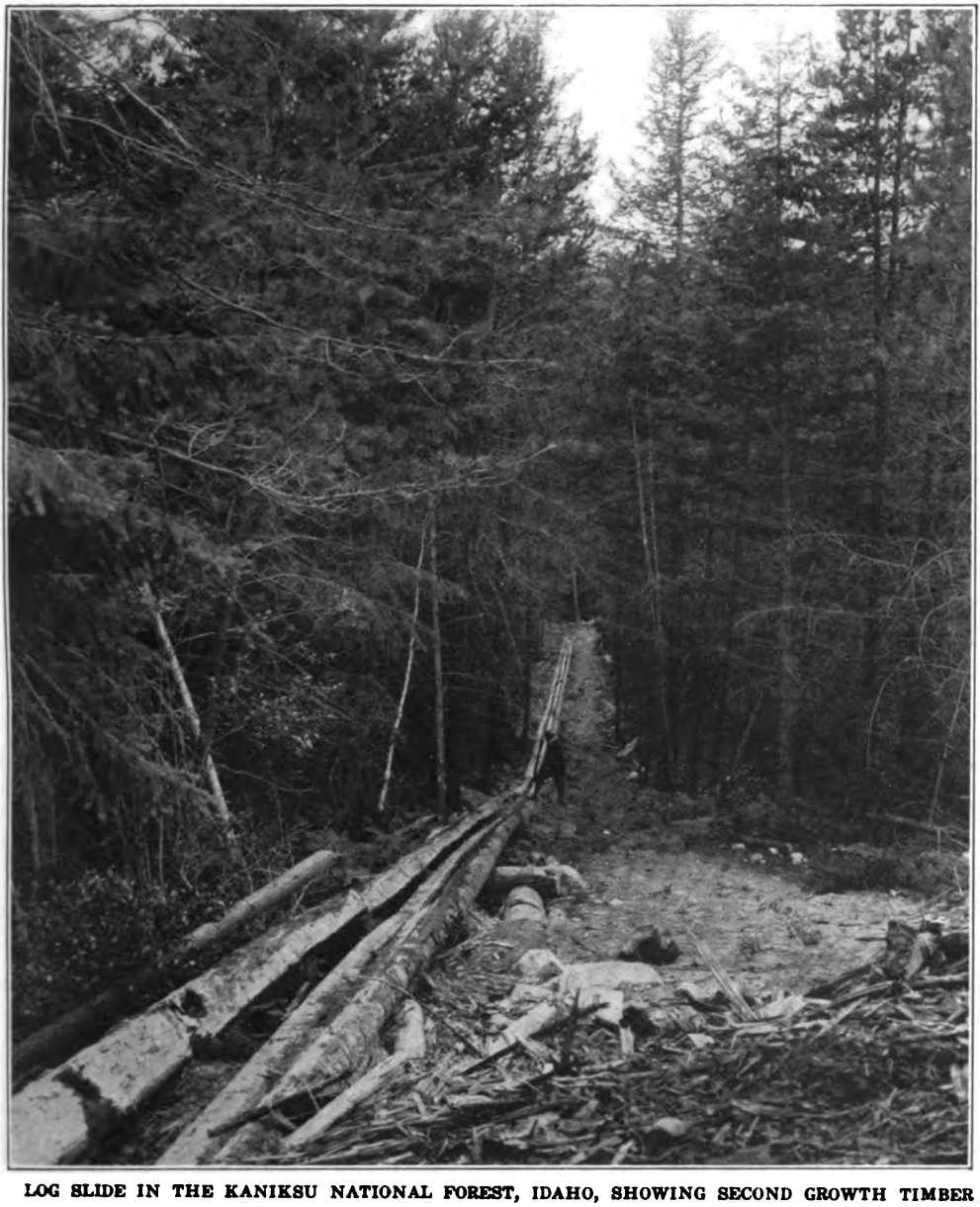

LOG SLIDE IN THE KANIKSU NATIONAL FOREST, IDAHO, SHOWING SECOND GROWTH TIMBER

to development just as on unreserved public land.

USE

The timber cut on the National Forests shows a substantial increase annually. In 1914 the cut, under sales, totaled 626 million board feet as compared with 495 million board feet in 1913, an increase of twenty-six per cent. The value of the timber cut was $1,271,000 as compared with $1,075,000 in the former year. Every effort consistent with sound management was made to increase the volume of sales. Desirable blocks of timber were appraised, placed upon the market, and widely advertised. The terms offered have been as liberal as

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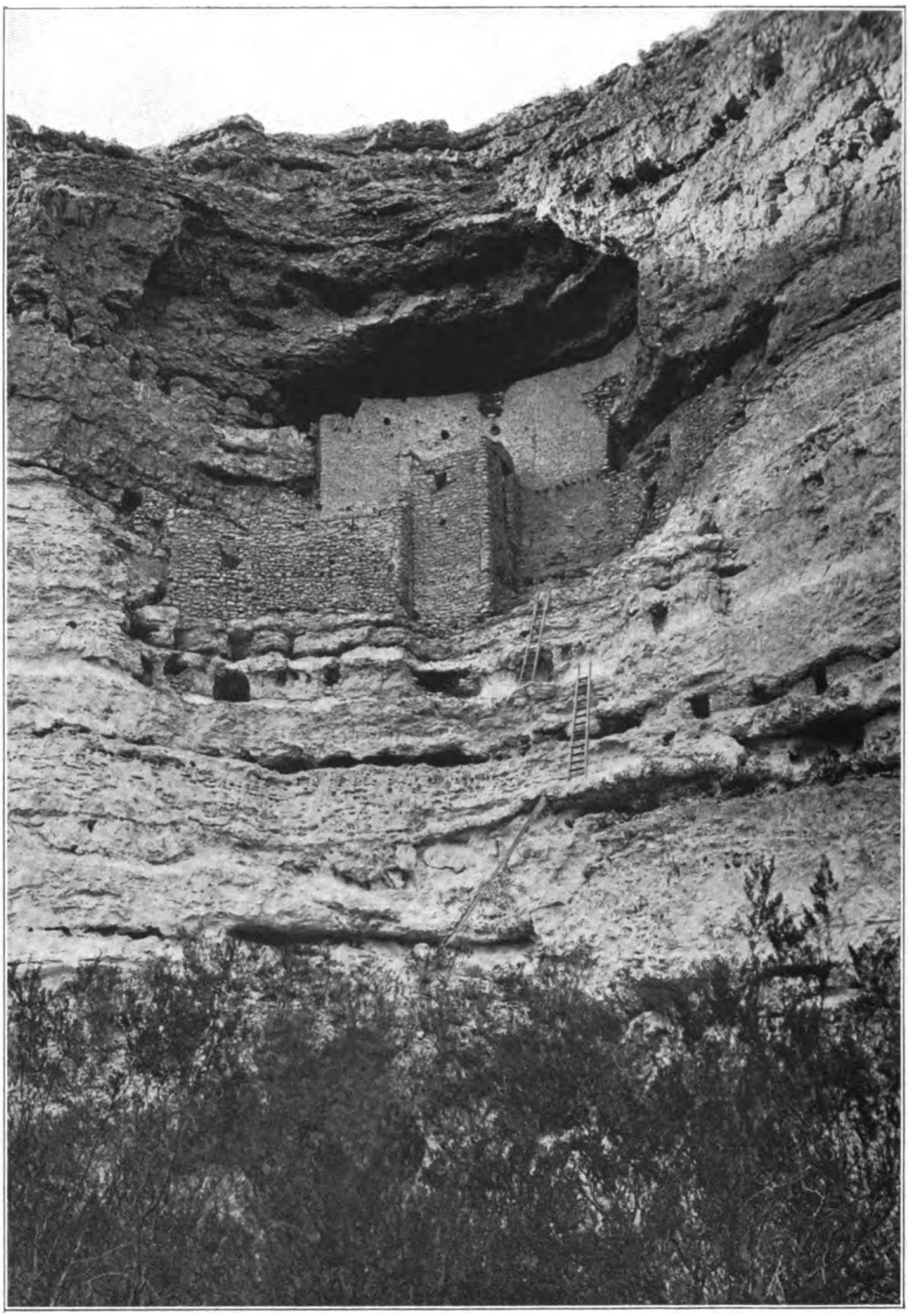

RUINS OF CLIFF DWELLERS IN THE COCONINO NATIONAL FOREST, ARIZONA, KNOWN AS MONTEZUMA CASTLE

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proper regard for the public interests would permit. Sacrifices in prices below the market value of the stumpage, as appraised by competent logging engineers, are not considered, as such action is deemed contrary to sound business policy. The reason why more sales are not made does not lie in the question of price, but is due to the inaccessibility of the National Forest timber compared with that under private ownership. The increase in small sales has been marked. The total number of sales during 1914 was 8,298 as compared with 6,182 in 1913. This indicates more general use of the National Forests for the supply of local needs, and an increase in the kind of sales business which the Forest Service is most anxious to develop. The average stumpage price obtained in commercial sales during 1914 was $2.32 per thousand board feet, an increase of twenty-two cents over 1913. On the Florida National Forest the timber now yields its chief revenue through turpentining operations, which brought in $13,372 during 1914.

There has been a significant increase in the amount of timber sold at cost to homestead settlers and farmers under the Act of August 10, 1912. 14,207,000 board feet was sold in 1914 as against 718,000 board feet sold during the preceding year. Under the regulations established by the Secretary of Agriculture, the homestead settlers and farmers on the National Forests and in their vicinity obtained this timber at an average cost of seventy cents per thousand feet.

The free use of National Forest timber for domestic purposes by settlers, local residents, and prospectors, varies but little from year to year, from 35,000 to 40,000 permits being issued annually for this use. Of the total amount taken, 31,826,000 board feet are live timber and 88,749,000 dead, with respective values of $85,160 and $98,060.

More than 1,620,000 cattle, horses, and swine, and 7,620,000 sheep and goats were grazed within the National Forests under permit by 29,000 stockmen in 1914. Under scientific management, the forage crop on National Forest lands is markedly improving in condition, productivity, and grazing value. The number of animals authorized to graze on the National Forests by the Secretary of Agriculture is increasing annually. The latest authorization totals 1,891,000 cattle and horses, 66,000 hogs, and 8,868,000 sheep and goats. Range conditions within the National Forests are being studied by experts, not only to increase the quantity of forage crops, but to make the ranges accessible to the stock. Systems of roads, trails, and drift fences are being extended annually, additional sources of water supply are being developed, and added protection is being afforded against losses through poisonous plants, predatory animals, and other agencies which tend to prevent the use of much good range land. Gains secured in this manner will not continue indefinitely, but no limit can as yet be set to the possibilities of increasing the present carrying capacity of forest lands through better methods of management and use, supplemented, perhaps, by judicious seeding.

Ninety-two hydroelectric power plants, eight hundred hotels, rest houses, and summer resorts, and fourteen hundred stores and other business buildings are now operating on the National Forests under permit. Seventeen hundred mining claims were patented during the past year within the National Forests, where the total mining population is more than twenty-four thousand. Twenty

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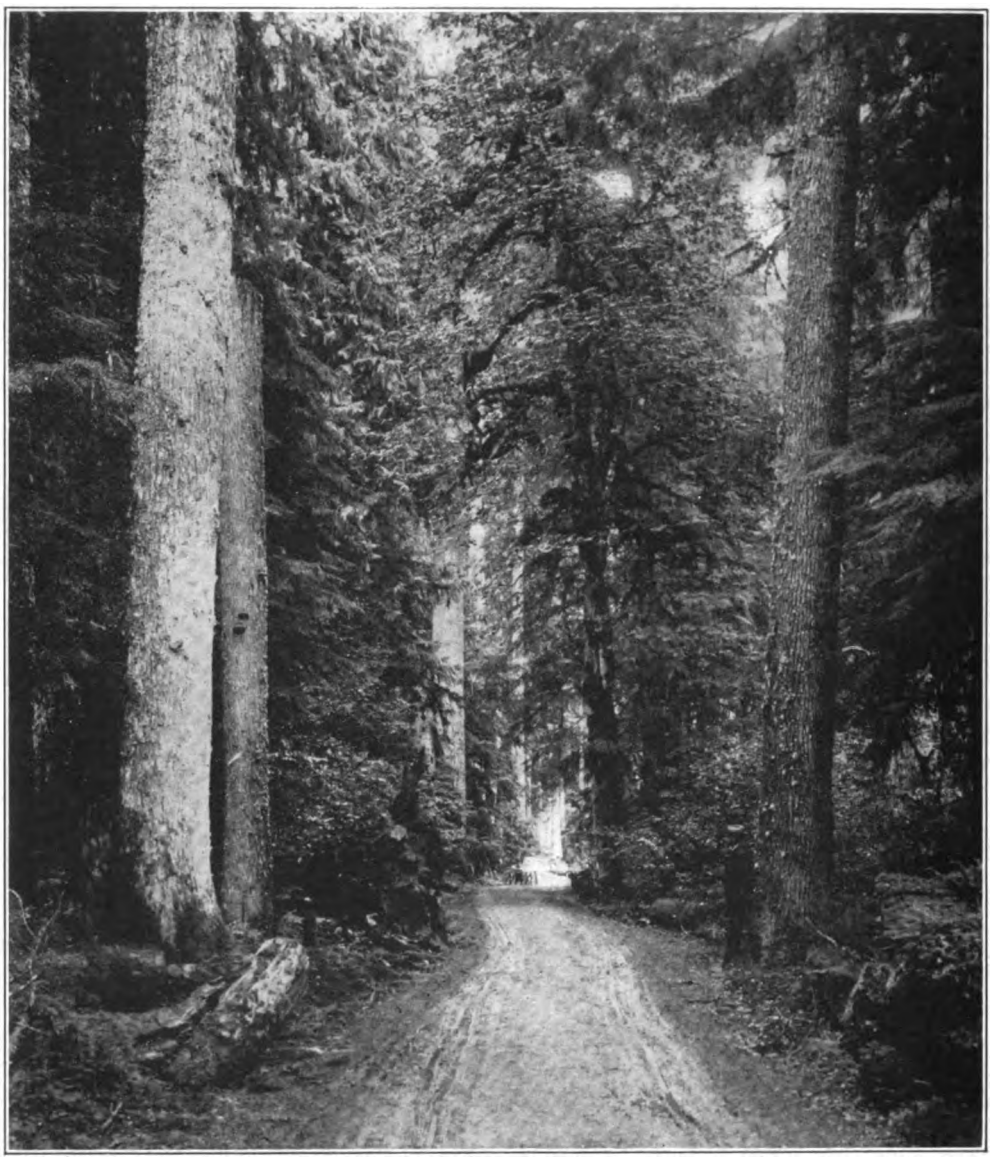

ROAD THROUGH VIRGIN FOREST NEAR ASHFORD, WASHINGTON

thousand permanent settlers occupy farms within the National Forest boundaries, one and a half million campers, hunters, fishermen, and other pleasure seekers used the National Forests as recreation grounds during 1914.

PROTECTION AND IMPROVEMENTS

The Forest Service extinguished 6,605 forest fires during the calendar year 1914. The value of timber and forage burned was nearly $700,000. Half of these fires burned over less than a quarter of an acre before they were put out. The development of an efficient fire department is progressing rapidly. The experience secured each year enables the Forest Service to improve its organization for the next year's work. As the funds ap-

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FIGHTING FOREST FIRE IN THE ADIRONDACKS, NEW YORK

propriated by Congress are small, when the great areas administered are considered, it can be appreciated that several years will be required before the fire-fighting system on the National Forests is fully developed.

Forest officers during the fiscal year 1914 killed 4,135 predatory animals, including mountain lions, coyotes, and wolves, in order to protect stock grazed on the National Forests. The wolf and coyote, the two species that do by far the greatest amount of damage to game and domestic stock, frequent the National Forests only during the months when game and domestic animals are most abundant. They are bred, born, and spend the major portion of their life cycle in the foothills and flats outside of the forests. Under these conditions the animals killed on the forests are replaced by others from the outside ranges, and this will continue to be the case until the Government initiates a general movement to destroy them throughout the length and breadth of the United States.

Poisoning operations against prairie dogs were conducted by the Government upon a number of National Forests with excellent results. There is little likelihood that the dogs will reestablish themselves within the areas treated. The funds appro-

FIRE TOOL BOX, U. S. FOREST SERVICE
Thousands of these boxes are scattered throughout the National Forests.

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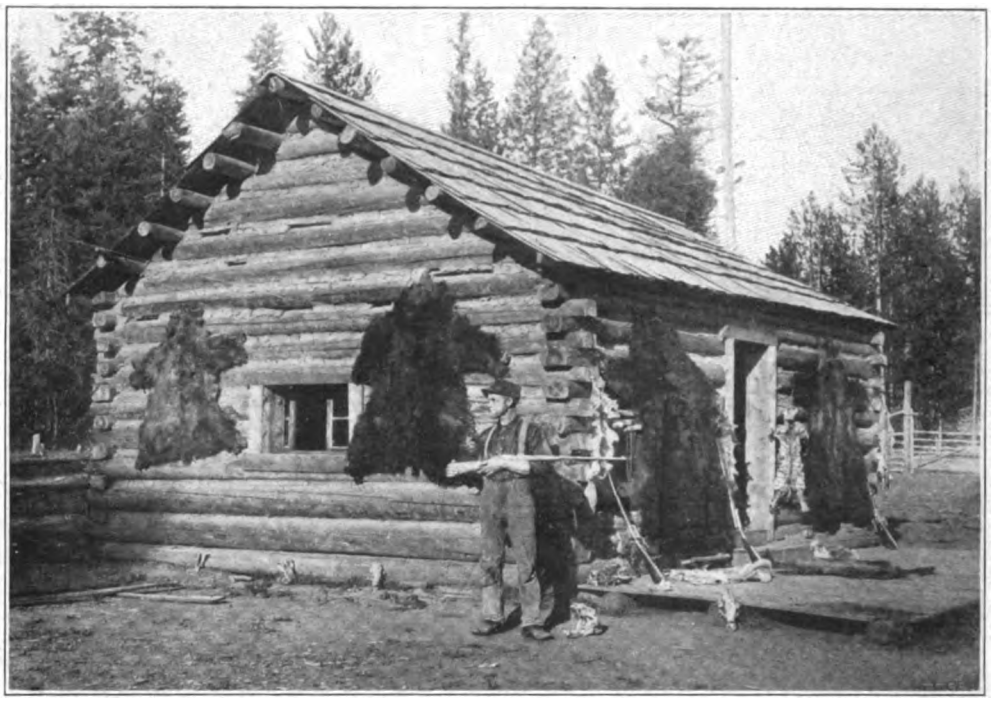

FOREST SERVICE HUNTER AND SOME OF HIS TROPHIES AT BILLY MEADOWS RANGER STATION ON THE WALLOWA NATIONAL FOREST, OREGON

The business of the hunters is to kill predatory animals such as bears, wolves, cougars, and coyotes, that molest sheep and cattle on the National Forest Ranges.

priated by Congress for this purpose are far too limited to meet the needs of the National Forests, to say nothing of the demands for similar work on other public lands. It would be economically advantageous for the Government to destroy systematically all prairie dogs, for the ultimate increase in grazing capacity would more than return the cost of the work.

During the past year 30,000 acres were sown or planted to young trees, making a total of 117,000 acres planted or sown on the National Forests to date.

The permanent improvement appropriation for the year 1914 was $400,000 and was employed for both new construction and maintenance. This fund was largely supplemented by odd-time labor of the regular Forest force. Besides repairing lines of communication and other permanent improvements damaged by winter storms, 270 miles of new road, 21,153 miles of trail, 3,063 miles of telephone line, 775 miles of fire line, and 106 fire lookout structures were built. Additional roads built by the use of the ten per cent road fund, derived from National Forest receipts, brought the total road construction for the year to 642 miles. There were also constructed 118 bridges, 461 dwellings, barns, and other structures, 19 corrals, 360 miles of fence, and 186 water improvement projects. The estimated value of all improvements on the National Forests at the end of the fiscal year 1914 was slightly over $4,500,000. More than 2,600 miles of road, 1,500 miles of fire line, 18,000 miles of telephone line, and 18,000 miles of trail have been built on the National Forests since they were transferred to the administration of

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HOME OF A FOREST RANGER IN THE COEUR D'ALENE NATIONAL FOREST, IDAHO

the Department of Agriculture in 1905.

Revenues

During the fiscal year 1914 the revenues of the National Forests were approximately $2,500,000. Of this $1,300,000 was from timber sales, $1,000,000 from grazing fees, and the balance from rentals charged for water power and special use permits. Twenty-five per cent of these receipts is paid to the State in which the revenue is collected, to be used for road and school purposes. In addition, ten per cent is expended by the Forest Service in the State where the money is collected, for road construction within the National Forests.

Disbursements

During the fiscal year 1914 the expenditures by the Forest Service totaled $5,735,000. Of this, $3,252,000 were spent for administration and fire protection, $980,000 for improvements, $1,200,000 for inspection, etc., $302,000 for forest investigations. It is expected that the disbursements of the Forest Service will remain constant in the future but that the receipts will increase rapidly as the National Forests become more accessible and as the private holdings of timber decrease in quantity. Congress makes appropriations for all of the expenses of the Forest Service.

State Forests

The fourteen States which have set aside forest reserves of their own, with an aggregate area of 3,400,000 acres, are California, Connecticut, Indiana, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Pennsylvania, South Dakota, Vermont, and Wisconsin. Thirteen States maintain nurseries which produce each year about ten million small trees, one-half of which are planted in the State Forests and one-half sold to private owners at cost, thus encouraging co-opera-

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OPENING TRAIL AFTER THE FIRE OF 1910. COEUR D'ALENE NATIONAL FOREST, IDAHO
Showing devastation in a heavy stand of Idaho white pine on the North Fork of the St. Joseph River.

tion in the effort to insure a timber supply for future generations.

Pennsylvania has 983,529 acres of State Forests, has planted to date 2,800 acres with young trees, produces 2,500,000 forest tree seedlings from its nurseries every year, has a number of State experiment stations, and makes an annual appropriation for forestry of about $328,000.

New York has 1,664,000 acres of State forests, has planted to date 7,000 acres, produces 4,500,000 young trees yearly, has established a State forest experiment station, and makes an annual appropriation for forestry of about $190,000.

Massachusetts has 15,000 acres of State forests and fifty-six separate municipal forests. Each year it produces from its nurseries upward of 1,300,000 young trees. The annual appropriation for forestry amounts to about $55,000.

Minnesota has 43,000 acres of State Forests, and makes an annual appropriation for forestry of about $233,000. Citizens of the State have planted 250,000 acres of their lands with trees.

Wisconsin has 400,000 acres of State forests, and makes an annual appropriation of $95,000 for forestry.

Forest Fires

Forest fires in the United States have destroyed, on an average, each year, at least twenty-five million dollars' worth of timber, and have caused, in addition, great losses in stock, crops, buildings, and other improvements. In the past fifty years more than 3,000 persons have been

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burned to death in forest fires. The Peschtigo, Wisconsin, fire in 1871 burned over 1,280,000 acres and cost 1,500 human lives. The Hinckley, Minnesota, fire in 1894, burned over 160,000 acres, with a death list of 418. The great Idaho, Montana, and Minnesota fires of 1910 swept 2,300,000 acres and burned to death 127 persons. Every fire that starts in a forest may develop into a serious conflagration. All that is needed is dry weather and a strong wind. In the State of Michigan alone forest fires during the ten years between 1901 and 1911 caused a loss of twenty million dollars. In Massachusetts forest fires from 1910 to 1913 caused a damage of over $800,000. Most forest fires are unnecessary and may destroy in a short period what nature has taken hundreds of years to create. Investigation has found that fires are nearly always the result of carelessness. The desolation caused by a forest fire can only be appreciated by those who have inspected a forest area before and after it has occurred.

Causes

The three chief causes of forest fires are found to be railroads, campers, and lightning. These causes are responsible for more than one-half the fires that start. Sparks from the smokestack and live coals from the fire-box are responsible for many of the fires that start along railroad rights-of-way. Hunters, pleasure seekers, and others leave camp fires burning or throw lighted matches or tobacco into highly inflammable material.

Protection

The Federal Government, twenty of the States, and thirty timber owners' associations maintain systems of patrol and take other preventive measures on their lands during the fire season. The area protected by the Government is approximately 184 million acres; that protected by States (largely in co-operation with the Government, as provided by the Weeks Law) 100 million acres, and that protected by the timber owners' associations, twenty-five million acres. The area now under some form of fire protection is slightly over half of the area of forest lands in the United States. As a result of these protective agencies the loss from fire is being considerably reduced. A wonderful advance has been made in the last few years, but every effort should be exercised to secure fire protection for the entire forest area. This will be accomplished by educating the public and the special interests involved as to the benefit that will accrue to future generations through the prevention of forest fires. If the great economic loss that occurs annually were appreciated by all, the people would unquestionably be willing to exercise the care and defray the expense necessary to avoid this evil.

Hunters, campers, pleasure seekers, and many who live permanently in the forests, are thoughtless in the use of fire. Now we have a superfluity of wood growth, but the day is not far distant that we will regret our thoughtlessness if each individual does not join the "protective band," pledged not only to prevent but also to extinguish forest fires. Timber would not only be preserved for future generations, but the beauties of the forest would be retained to be enjoyed by all.

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THE WAR AND ITS BEARING UPON CONTRACTS AND TRADE

By Alex. Del Mar

Mr. Del Mar reviews briefly the progress of the war and the resources of men and money of the contending countries. He then discusses the financial aspects—future rate of interest, the shipments of gold and American securities to this country, war loans, moratoria, etc.—and their probable effect upon American industries and prices.—THE EDITORS.

MANUFACTURERS, merchants, and engineering contractors are becoming increasingly interested concerning the bearing of recent and pending financial operations and plans upon their trade and industries. Undertakings of every nature, some of great magnitude, hang upon these considerations. The available resources of the nations at war; the recent colossal borrowings of European and Colonial governments; the trend of gold to this country; the past, present, and probable future rates of interest for money; the prices and tendency of staples; and a variety of kindred matters are being seriously discussed in counting houses.

The rapid march of international events and their imperative demand for public attention has scarcely left sufficient pause for the discussion of these difficult problems. Yet as every day in the military imbroglio threatens to increase their number and complexity, a survey of them as they now appear, may serve to clear the way for future contemplation.

PROGRESS OF THE WAR

Thus far the Allies have put an end to the seaborne commerce of Germany and practically terminated her empire in Africa and her hold upon the Orient; both of the latter being of far greater importance than is apt to be considered by an absorbed spectator of the gigantic struggle in Europe. The loss of Africa resigns that vast continent entirely to the Allies; the capture of Kiou Chau not only releases China from German exploitation, it frees Hong Kong from what has been regarded as a galling preponderance of German trade monopolies. More than all, the employment of Indian troops in Europe is an event of profound political and commercial significance.

On the other hand, the Germans have extended their sway over the whole of Belgium and Russian Poland, together with some portions of France; while thus far they retain the great advantage of military concentration, abundance of arms and munitions, and the ability to supply their commissariat from the territory of their adversaries.

Both sides having declared the war *à toute entrance*, its duration and ultimate result seem likely to turn not upon these initial or temporary advantages, but rather upon the ability of the contestants to retain them; and as the agricultural, manufacturing, engineering, and commercial future of the United States is likely to be seriously affected by the outcome, it seems necessary to examine with

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some degree of care the opposed resources of men, materials, money, credit, intellect, and invention, for to regard these last as no part of the forces in conflict would be a deplorable blunder. As well in war as in peace, a large place in the cadastre of national resources must be assigned to superior credit and invention.

Resources of Men

So far as population is concerned, the Allies appear to command five times as many men as the Germans. Employing the enumerations of 1910-11, using only round figures and excluding African auxiliaries on both sides, the United Kingdom has a population of about 45 millions; British Colonies and Dependencies 340; France 40; French Colonies and Dependencies about 20; Japan and her Colonies 70; Russia, including Russian Poland, the Caucasus, Central Asia and Siberia 155; Serbia 3; Italy 35; and Belgium 8; total 716 millions.

On the other hand stands the German empire with 65 millions; the Austrian empire, including Hungary, Croatia, Slavonia, Bosnia and Herzegovina 51; and Turkey in Europe and Asia 24; total 140 millions. This is five to one.

Even if 200 millions are deducted from the population of British India; and all of Japan, Siberia, and Belgium, and five-sixths of Russian Poland are omitted, as being (at least for the present) out of the conflict, the Allies would still command a population of 420 millions, or three to one of their adversaries.

Wealth of Nations

From population to wealth. At the same date of 1910 the British Empire, including Colonies and Dependencies, was assessed upon a capital valued at 110 billion dollars; France and her Colonies, etc., 40; Russia and her Dependencies, 90; and Italy and her Colonies, about 40; total, 310 billions. The wealth of India included in these estimates is limited to 15 billions, which seems rather low.

On the other side, the German empire has a capital of about 64 and Austro-Hungary about 40 billions; together 104 billions. This is again three to one, in favor of the Allies. Turkey is bankrupt. She has little money or credit and but few intellectual resources available beyond her own frontiers; nothing to utilize or sell, except her lands, which even now are being fiercely contested, and except her agricultural crops, which she will need for her own sustenance. A brave, industrious, ingenious, but badly governed nation.

Ready Money

From national wealth in lands and goods to ready money and credit. In 1900 the four principal Allies, the United Kingdom, France, Russia, and Italy, possessed of gold coins and gold bullion in banks or treasuries or in circulation about 2,000 million dollars; at the beginning of 1914, about six months before the War, these funds had increased to about 2,875 millions; at the outset of the present year they amounted to 3,650 millions; of which the United Kingdom and France controlled about 2,400, Russia 1,000, and Italy 250 millions. In addition to these resources, the highly productive gold mines of Africa, Australia, Canada, etc., are owned by the British; while those of the Ural and Siberia are controlled by the Russians. Together these various mines yield over 300 millions per annum, or five-eighths of the entire annual gold product of the world; the whole of which proportion is subject to their absolute disposition, with markets in which to dispose of it as wide as the entire commercial world outside of Germany.

The German position in respect to

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gold resources and their current and future supply, exhibits a singular lack of foresight on the part of her statesmen. Both Germany and Austro-Hungary possess productive silver mines, but no important gold mines; yet each has made its engagements in in a metal over which they have no territorial control, and for supplies of which they are committed to the disposition of a commercial rivalry that has since ripened into unconditional hostilities. Whether the indemnity exacted from France in 1870 remains locked up at Spandau or is merged with the general assets of the Reichsbank matters now but little in its bearing upon military resource. German commerce is paralyzed, and neither Germany nor Austria can buy much more with their gold, than can be procured without it; whilst as for future supplies, they will inevitably be thrown back into the same condition of subserviency of which they now complain. It is their own fault; and as John G. Fichte, one of their own counselors has shown, they cannot escape its consequences. Meddling with long established monetary laws is so dangerous a sport that Mr. Fichte condemned it as high treason.

In 1900 the fund of gold and gold bullion in Germany was about 600 million dollars; in Austro-Hungary about 280 millions; in 1913 these funds which embrace banks, treasuries, war-chests, and circulations, were respectively about 863 and 295 millions; in 1914 about 900 and 333 millions; whilst at the beginning of the present year they appear to have increased to about 1,000 and 500 million dollars respectively. Some of this metal has probably escaped the blockade and found refuge in other lands, where it has served, or may yet serve, to purchase supplies and services.

Extension of Credit

Owing to her numerous colonies and possessions throughout the globe, her command of the seas, the colossal dimensions of her merchant marine and carrying trade, this element of military strength belongs largely to Great Britain and exclusively to the Allies; their only second in this respect being our own great neutral government. Germany may find means to borrow a few million dollars from German natives beyond the seas, but probably not more than can France, from her compatriots abroad. The amplification of credit outside of their own frontiers will probably afford but small essential assistance to the other contestants.

The vast extent to which Germany is borrowing from her own circulation of gold is partly shown by the accumulations of the Reichsbank. Upon the commencement of hostilities the gold holdings, exclusive of the war-chest, amounted to about 200 million dollars. Last May they had increased to 600 millions, whilst during the same interval of time the substitution of greenbacks for gold in the circulation rose from 600 to over 1,400 million dollars, from which it may be inferred that something like 800 millions were withdrawn from circulation or hoards. The severity with which metallic hoards are commandeered is illustrated by the fines imposed in Bavaria for attempts to evade the armament tax. In some cases these fines amounted to twenty times the sum concealed or withheld. Unless Germany has succeeded, or may yet succeed, in opening up a large foreign trade with its gold, it is difficult to see to what critical use she can put it; for in the absence of commerce with important manufacturing countries, the gold can be of little military assistance while the blockade lasts.

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Culture—Intellect—Invention

Great superiority has been claimed for it by enthusiastic admirers of German imperial culture. Such superiority, if it has any miltiary bearing at all, must be confined to inventions. But when it is recalled that the most important devices which this war has called into active use were of American, British, French, or Italian invention, it can hardly be claimed that culture has yet afforded the Germans any marked advantage in the field. The trench and fortified camp, the helmet and pavise are Roman, and were employed by Cæsar nearly two thousand years ago, and upon the very same lands of Gaul and Flanders which are the principal scenes of the present conflict. The Greek fire and Chinese stink-balls are still more antique weapons of war. The steamboat, telegraph, field telephone, automobile, submarine ship, breach-loader, revolver, Maxim gun, and high explosives are American inventions or improvements.* The bicycle, steam engine, and steam locomotive are British. Rifled ordnance and conical bullets are French. Wire telegraphy and field glasses are practically Italian. Printing and paper money (the latter already playing an important part in the present war) are both of Chinese invention and very ancient.

History repeats itself. While the Athenians under Persian imperial rule were chanting the foreign odes of Linus or Maneros, the Romans of the republic were inventing the cross-bow and ballista—devices of far more importance to a nation's security and welfare than strains of music, however emotional.

Such in brief are the material forces arrayed in conflict. The Allies are stronger in men, wealth, ready money, credit, and invention; the Germans in military organization, discipline, concentration, interior communications, and transportation. If it were a mere question of enthusiasm, the war might last for years; if of material resources, the end cannot be so far off that our merchants, manufacturers, and engineering contractors shall find it difficult to arrange their affairs so prudently as to meet successfully any new conditions which European peace may impose.

Future Rate of Interest

It has elsewhere been shown upon a somewhat convincing array of historical evidence that all interest upon loans of capital grows out of and takes its rate from general profits in trade, and that these are controlled in the long run by the average rate of the reproduction of domestic animals and plants under man's superintendence. For example, if wheat farming yielded 100 instead of 15 bushels to the acre, no man would lend his money at 5 per cent, because a greater profit could be made by investing it in agriculture. The two other elements of interest are risk of the capital and cost of superintending the loans, such as taxes, legal expenses, notarial fees, brokerage, stamps, etc. Upon these economical grounds and taking into consideration the increased and increasing yields of agriculture effected by modern inventions and applications, it was argued in a previous number of The Engineering Magazine,† that the rate of interest for money was bound to advance. Events have justified the fore-

* There is a British revolver in Warwick Castle, England, which antedates Colt's pistol; but so is there an Arabian revolver in Vienna Museum which long antedates both. A similar remark applies to breach-loaders which the Arabians invented, the Spaniards copied, the English used at the battle of Cressy, and Cortez employed for the conquest of Mexico. A Chinese breach-loader, several centuries old, with the regnal date upon it, is now at the U. S. Navy Yard, Mare Island, California.

† The Engineering Magazine, October, 1914.

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cast. Government and municipal three per cents have given place to fours, and since the war the fours to four-and-a-halves. There is little risk in predicting that the latter must in no very great length of time give place to fives. Sir John Paish has claimed that Great Britain was already earning an average of 5.2 per cent upon all her foreign investments. But as the majority of these include elements of commercial risk, they cannot be strictly compared with interest-bearing national securities, in which the element of risk (in peace times) is negligible.

While the gradual improvement of agriculture and the economical and profitable influence of inventions, devices, and processes both continue unabated, the war has added something to the element of risk on loans of capital—how much more, it is difficult at present to compute or foresee; but enough to stimulate the rise in the rate of interest for money. There will doubtless come a time when the devastations of war, in sweeping away men, structures, and improvements, will impair the earning power of capital and with it the profits of production and trade and the consequent demands for loans of money; but this condition is not universal and the time may yet be far off. Forecasts in times of war lose their application with the resumption of peace; just as predictions in times of peace are hazardous when applied to a condition of hostilities.

Gold

The trend of gold to the United States can scarcely be regarded as permanent. It is not wanted by our mints. Gold coins are not and never have been popular with us for money, but only as security for other fiduciary issues; while even for this purpose, such is the solid character of our Government and the confidence and intelligence of our people, that the security of gold coins is only demanded to a very limited extent. This is clearly shown by our Treasury and banking accounts. The consumption of gold in the arts, though far greater than is commonly supposed when compared with our current production of that metal, is wholly unable to cope with large and continuous importations from abroad. The gold at present being shipped to this country, whether for security or investment, will be worth more elsewhere; and in time will doubtless find its way to other countries, whose need for it will be greater than our own.

Return of American Securities

One of these influences may fitly be adverted to in this place, namely, the apprehended return of American securities and their sale here for gold. But it is to be remarked that an urgent requirement for gold in the warring states is not universal. It scarcely exists in Great Britain, which is plentifully supplied from its own mines. It exists to no greater extent in France, whose finances are intimately connected with those of her principal ally. In both countries, especially Great Britain, such American securities as they possess are largely in the hands of fire and life insurance companies who transact American business, and who are obliged to deposit these very securities with the States in which they are operating. They afford necessary safeguards to their policy holders in America and other countries and are not likely to be placed upon the market, except temporarily and to a limited extent, upon the issue of new war loans. Though not in use they draw interest; whilst gold, when not in use, draws none. Nor can they be replaced with British securities, because the latter might not prove acceptable to the American and other State authorities,

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who are restrained in their choice by strict laws.

Neither Austria, Russia, nor Italy possesses any considerable holdings of American securities; nor are there any known to be held in Serbia or Japan. In short, the only one of the warring States which is likely to throw its American securities upon the American market is Germany, and the probability is that this has already been done to the utmost practicable extent; for German holdings are largely pledged, as are those of Great Britain and France, with the insurance authorities of the various foreign States in which they transact business. Some of the American securities now coming home from Great Britain are probably of German origin.

On the whole, it does not appear likely that any considerable amount of American securities will be thrown upon our markets. Indeed, from a purely business point of view, the holders will probably be disposed to regard them as among the best of their assets.

Cost of the War

According to press dispatches, Premier Asquith, at the Guildhall meeting, June 29th, estimated the "total prospective expenditure for the year at nearly a thousand million pounds sterling, ($5,000,000,000) and the daily expenditure as likely to be, for weeks and months to come, something like three million pounds, ($15,000,000)." This was understood to mean the British expenditure alone. And he "dismissed as impracticable the idea of selling investments in property, or of borrowing abroad." On the same day, after appeals by Premier Viviani and War Minister Millerand, the French senate approved a bill appropriating 1,120,000,000 francs ($224,000,000) for national expenses during the third quarter of the year. This does not appear to have included the cost of the war. In July, M. Ribot, Minister of Finance, introduced a bill in the Chamber of Deputies raising the issue limit of national defense bonds from six billion francs (law of May 18) to seven billion francs ($1,400,000,000), stating that the French people in eleven months had taken 8,400,000,000 francs of national bonds. These contributions amount to over $5,000,000 per diem. Adding cash expenditures from previous treasury balances, the war seems to be costing France something near $10,000,000 per diem. The combined expenses of Russia and Italy can scarcely be less than another $10,000,000 per diem, and of Japan and Serbia not less than $2,500,000. These sums make a grand total of about 37½ millions per diem, or over thirteen billions ($13,675,000,000) per annum, of which Great Britain contributes 40 per cent and will probably be called upon, through her commercial channels, to negotiate abroad some portions of the remainder.

Other War Loans

A few days before Mr. Asquith spoke, the British Finance Minister, Reginald McKenna, obtained from the House of Commons authority to issue a 4½ per cent war loan, unlimited in extent, and to raise the outstanding 2½ and 3½ per cents into 4½ per cents, provided at the same time the holders shall double their investment. This will affect $3,000,000,000 of 2½ per cent consols and $2,400,000,000 of 3½ and 3¾ per cent recent war loans. To whatever extent such conversions are likely to take place, the British debt at the end of a year from say the thirty-first of last March, (assuming the war to continue) was estimated by Lord Middleton in open parliament at not less than the sum of 1,293,200,000 pounds sterling, ($6,400,000,000) an estimate

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to which the Government minister, Lord Lansdowne, made no objection. It will probably be nearer the mark to estimate it at a third more, say ten billion dollars, with an annual interest charge sufficient to absorb the entire current product of the British gold mines.

Upon the unlimited authority granted to the Treasury, it immediately issued a 4½ per cent war loan of 1,250 million dollars, the whole of which was taken up "in new money," apart from conversions, before the middle of July, of this year, and chiefly by British banks and insurance companies.

At about the same time Russia issued a new 5 per cent gold bond on the "foreign" (mostly the British) markets for 200,000,000 rubles, ($103,000,000) followed by a domestic 5 per cent gold loan of 1,000 million rubles, ($515,000,000,) all of which latter was taken up by the domestic Russian banks at 97½ to 99 for par bonds.

Dr. Karl Helfferich, Imperial Treasurer, is quoted as having estimated the war expenses of Germany above those of Great Britain, but if we put them merely at the same figure of 15 million dollars per diem, adding 15 for Austro-Hungary and Turkey combined, it would make a total of 30 millions per diem, or 11 billions per annum. Two Austrian loans, each of 125 million dollars, have already been placed upon the German market, and others are likely to follow.

The details of Germany's war loans have not transpired with satisfactory clearness. The circumstances of her first war loan (1914) are clouded; while those of her second loan (February, 1915) of $2,250,000,000 are mingled with conversions of the first. The total of war loans to date can hardly be less than four or five billion dollars, with interest nominally at 5 per cent, but really more, because the loans were marketed at less than par.

Shortly after midsummer 1915, the government of Spain issued a domestic gold bond of 750,000,000 pesetas ($150,000,000) at 4½ and 4¾ per cent; while the Serbian National Assembly voted an additional credit of $50,000,000 for the continuation of military operations.

Italy has also made large issues of gold bonds; and in all the countries at war, as well as some other countries likely to join in or to be jeopardized by the war, the taxes have been greatly increased, the rate of interest has advanced and gold has disappeared, or is rapidly disappearing from circulation, most of it finding its immediate way into the hands of government depositories, in exchange for bonds. Even neutral Switzerland, apparently secure from molestation, issued a loan in July for $20,000,000 at 4½ per cent, selling it at 96½ for par; the proceeds being destined to cover the cost of mobilizing her army.

Moratoria

Moratoria have been declared in all of the warring States and many others, including several in Latin America. In Great Britain and France these moratoria have been wholly or partly repealed. In other States they have been modified, terminated, or renewed, as circumstances demanded or interest prompted. In all of them civil suits against debtors who have joined the colors are forbidden, an ancient Roman provision, which hastens many accessions to the ranks. However, the general intent of the moratoria has been not to strengthen the ranks but to save annuitants, investors, merchants, contractors, brokers, and others from unmerited loss or ruin through the operations of war. It is possible that some even of those already repealed

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or modified may be reinstated, as the struggle continues.*

American Affairs

Turning now from scenes of carnage and desolation in Europe to our own peaceful and comparatively prosperous domains, it is to be observed at the outset that the European war has not occurred, indeed could not have occurred, without inflicting injuries and losses upon this country. Neutrality has been violated, precious lives sacrificed, ships sunk, others on lawful voyages detained at great loss to shippers and owners, our foreign commerce generally interrupted, and business activity at home halted to the point of occasioning great loss and discontent among the stipendary classes. These are inflictions for which the profits of a comparatively few dealers in war materials afford no adequate compensation. The only capital that mankind at large possesses, is *time;* and the earnings of a vast number of people have been impaired through non-employment. The capital, the time of the industrious classes, has been diminished in value owing to the quarrels of distant peoples, none of whom will, or can, offer us any compensation. However, our main reliance, the farms, pastures, and mines, have been generously rewarded by nature, the cotton and tobacco planters being the chief sufferers, not from lack of liberal crops, but of customary markets. Our produce of gold, silver, copper, lead, iron, coal, petroleum, etc., has more than kept pace with the bounty of agriculture, and our manufactories have not been entirely idle.

Prices

In a comprehensive article on this subject which appeared in a back number of THE ENGINEERING MAGAZINE,† it was shown from the sworn manifests of domestic exports for a series of years, amounting in aggregate value to the enormous sum of 15 billion dollars, that prices had advanced during the previous decade nearly 50 per cent; while the causes of this rise, after a most searching inquiry, were found to be neither the increased production of gold, nor extravagant living, nor urban congestion, nor inadequacy of natural resources compared with growth of population, nor indeed any of the causes alleged by the various economists who had recently treated the matter, but to two overlooked causes, namely, the enormous increase of taxation and the enhanced velocity of money due to steam and electrical inventions. The latter were chiefly steam railways and electrical telegraphs and telephones. We quote:

Future Prices as Viewed in 1910

In relation to the productive, economical, and fiscal operations of a great country, especially with those of the newest, the most extensive, and the most powerful State in the world, whose economic policy is necessarily subject to much experiment and change, it is extremely hazardous to predict. But if we permit our judgment to be guided by three or four great lines of national figures, which, ever since the foundation of the Republic, have exhibited a constant though not uniform rate of increment, the future level of prices, concretely the future cost of living, unless modified by a radical change of fiscal policy, *seems almost inevitably bound to rise still farther.* These lines of figures represent the steady growth of population; the steady growth of productive capacity; the steady increase of circulating money and the increase of the transporting facilities and credit devices which enhance its velocity; and the recent and enormous increases of taxation (federal, state, and local), which, from something less than one billion in 1897, has now reached two-and-a-half billions and is still pointing upward.

The future, as indicated by these lines, points to still higher prices. Nor can we regard such further rise as likely to be materially retarded by any of the otherwise laudable and well-meant acts of legislation which have been lately secured by our public men and representatives.

* Details of the various European and Latin-American moratoria can be obtained from the Latin-American Chamber of Commerce of New York. They merit the careful study of contractors.

† See THE ENGINEERING MAGAZINE, July, 1910.

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As will be seen below, this prediction of enhancement has been fully borne out by a further advance of prices since the above was written, of about 20 per cent. Upon comparing the export prices of 1915 with those selected for illustration in 1908 we have the following results:

COMPARISON OF EXPORT PRICES

Fiscal years ending June 30th.		1898 Cents	1908 Cents	1915 Cents
Cotton, raw	lb	.059	.118	.084
Cotton, manf'd uncolored	yd	.047	.067	.068
Cotton, manf'd, colored	yd	.052	.072	.071
Bacon and hams	lb	.077	.109	.140
Lard	lb	.056	.091	.118
Pork	lb	.056	.089	.110
Beef	lb	.055	.068	.126
Butter	lb	.150	.218	.241
Cheese	lb	.086	.129	.150
Leather	lb	.175	.211	.292
Wheat	bu	.885	.990	1.260
Corn (maize)	bu	.314	.680	.800
Tobacco	lb	.100	.150	.127
Sugar, refined	lb	.040	.040	.046
Fourteen principal staples..		$2.152	$3.032	$3.654
1908 over 1898, per cent....			40	
1915 over 1908, per cent...				70

NOTE:—Manufactured lumber and leather removed from this table. They do not affect the percentages of advance in prices.

A FURTHER RISE OF PRICES

In addition to the influences shown to have caused a steady rise of prices in the past, other influences have more recently been created or made their appearance, whereby the upward movement of prices, otherwise diffused, settling into permanence, and losing its momentum, is reinforced and renewed. These are wireless telegraphy, the "Federal" reserve banking system, the issuance of additional bank notes (166 millions over last year), and the influx of gold from Europe. The first thus operates by placing our merchants and bankers in communication with markets and commercial centres not so readily reached by telegraph; the others by rendering promissory notes and bills of exchange more liquid, and in further stimulating prices through the enlargement of the currency. These influences are so recent that it is hazardous at present to compute their force with any degree of precision. It can only be said that they all point to a continued rise of prices; a rise, however, that is not likely to become any more rapid than heretofore. The item which should, but probably will not, occasion the most concern, is the pressure of taxation. The taxes are permanent, increasing, and as wastefully expended as ever; but as they do not fall direct, they will meet with indifferent attention. Colossal as is the burden they impose, it is not so much its vast total in dollars (for that depends upon what we get for it) as its uneconomical expenditure, which renders it intolerable to the manufacturer, contractor, and stipendiary.

For the most part taxes in this country are imposed upon real estate. These, by at once affecting rents, enhance the prices which tenants, who have to pay the enhanced rents, are compelled to demand for their commodities or services. A rude measure of the resulting enhancement of prices can always be computed by comparing export with retail prices; a considerable proportion of the difference being due to taxation. As they usual-

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ly lease on long terms, our manufacturers and contractors as a rule will not be immediately affected by these circumstances; but they can scarcely hope to escape their influence upon the cost of living and therefore upon the price of labor, unless indeed this last consideration should be balanced by conditions which are not unlikely to follow the conclusion of peace.

Future Prospects

Such is the degree of international intimacy and correlation in commercial affairs which modern politics, legislation, and above all modern invention have brought about that a great war in any part of the world is certain to disturb and upset all the rest of it, though of course in varying proportions as to each community. The destruction of life and property cannot be confined in their effects to the immediate contestants; they are bound to be felt everywhere else. All the world will be unconsciously compelled to take part in and contribute something towards the necessary rehabilitation. Among the present consequences of the European war is the dwindling of our seaborne commerce, which, in spite of an optimism that looks hopefully to the Southern hemisphere, may never be fully recovered, or if recovered, not appreciably increased, no matter which way the war ends. The fundamental basis of all seaborne trade is the wage paid to seamen and the cost of provisioning and coaling a ship. This basis is not subject to the control of the United States. Indeed, we are not so much a commercial as an inventive and manufacturing nation. Therein is our advantage, and no other nation will ever deprive us of it; because it rests upon superior education and permanent institutes of political liberty.

With the conclusion of peace we shall inevitably inherit the agreeable and profitable task to feed, clothe, and furnish, not only some parts of Latin-America, not only all Europe, for a time, but likewise and for all time those vast and intelligent populations of the Orient whom the war has measuredly enfranchised, but who in great part are as yet poorly fed, scantily clothed, yearning for a share of the world's goods, and withal peaceful, hard working, and able to pay for what they need with the products of their own industry. The trade of Asia may not be largely carried in American bottoms, but that trade will nevertheless be ours, provided we take the proper measures to secure it while the occasion serves.

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THE COST OF HANDLING MATERIAL WITH MOTOR VERSUS HORSE-DRAWN EQUIPMENT

By Henry F. W. Arnold

Mr. Arnold cites a not unusual case wherein a manufacturing plant, using three two-horse teams for short hauls to and from railway freight depots, experimented by substituting one gasoline motor truck. The tests and their analyses will serve as models for others who may be contemplating a change.—THE EDITORS.

WILL it be to our advantage financially, or otherwise, to replace our horse-drawn vehicles with automobile equipment? This question is frequently before the minds of officials and owners who have to deal with the problem of transportation of material, and who desire to practice a progressive policy in so far as they are justified in so doing by economic considerations.

That this question will yield a logical answer, if the proper analysis is made, the writer hopes to demonstrate by citing the following specific case in which it was shown that the substitution of one five-ton automobile truck in place of three two-horse-drawn vehicles would result in a considerable annual saving. Naturally, the degree of correctness of the answer will depend on the thoroughness with which the analysis of the existing conditions is carried out.

The capacity of the motor truck and type of body may be readily determined by the character of the material to be transported and the distances to be covered.

In order to obtain reliable data upon which to base a comparison of the results obtained from the use of automobile truck equipment versus horse-drawn vehicles it is always desirable, and generally feasible, to have the dealer demonstrate the ability of his truck to perform the work in question. Even when a predilection exists in favor of some special make of truck it is well to encourage a demonstration of several makes, in order that a careful comparison may be made of the specifications and behavior of the different trucks under actual working conditions.

The case that we will consider as a typical example is a manufacturing plant whose product consists of light and heavy machinery, the latter predominating. Although the plant is located on a trunk-line railroad and has its own spur loading tracks, it requires the services of three two-horse trucks to haul machines and material to and from the freight-houses and to make the necessary local deliveries. The management desired to know if the three-horse-drawn trucks could be supplanted by one automobile truck and what advantages would accrue financially, or otherwise, if the change was made.

A careful analysis of the existing conditions, considered from all angles, established the fact that a five-ton gasoline truck would best meet the requirements of the service in question. Accordingly several demonstrations were arranged for.

During the demonstration a careful log was kept of the performance

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of the automobile trucks and all matters of interest noted. A corresponding log was also kept of the horse-drawn vehicles for the purpose of comparison. Tables I and II show two representative logs kept during the test at the above plant. This form of log contains all the necessary information, and has been used frequently with good results.

From a comparison of the summaries of the two logs, we find that the motor truck has 73.66 ton miles to its credit (a figure that can be taken as a fair average of the daily performance of the truck under normal

TABLE I

Log of 5-Ton Gasoline Truck Demonstration. Name of Truck ———. Weight, 10,800 Pounds. Remarks, ———. Date, April 24, 1914. Weather, Rain. Temperature, 50 F. Client, ———.

Depart		Arrive	Minutes						
Place	Time	Place	On Road	Loading	Miles	Load Lbs.	Ton Miles	Roads	Remarks
Shipping Dept.	7:00 7:08	P. R. R. Ft. House	8	24	0.9	Empty	0.0	Good Brick	
P. R. R. Ft. House.	7:32 7:41	Shipping Dept. ...	9	18	0.9	Steel 8280.	3.73	"	See ..Note 1
Shipping Dept.	7:59 8:11	B. & O. Ft. House	12	42	1.0	Mchy. 11250.	5.63	"	
B. & O. Ft. House.	8:53 9:09	Shipping Dept.	16	38	1.25	Motors 12400.	7.75	Repairing ..	See ..Note 2
Shipping Dept.	9:47 10:05	Foundry .	18	59	1.30	Iron 9800	6.37	See Note 3	See ..Note 4
Foundry .	11:04 11:21	Casting Shed	17	52	1.30	Iron 13850.	9.00	"	See ..Note 5
Shipping Dept.	1:13 1:44	Concrete Supply Co.	31	46	3.90	Mchy. 9200.	17.9	Good Brick	See ..Note 6
Concrete Supply Co.	1:59 2:20	Forge Co..	21	22	2.80	Empty	0.0	"	
Forge Co.	2:44 2:58	Stock Dept.	14	41	1.40	Shafts 14100.	9.87	"	
Shipping Dept.	3:39 3:51	H. V. Ft. House.	12	48	1.40	Mchy. 11300.	7.91	"	
H. V. Ft. House.	4:39 4:45	B. & O. Ft. House.	6	36	0.60	Empty	0.0	"	
B. & O. Ft. House.	5:21 5:29	Shipping Dept.	8	28	1.25	Steel 8800.	5.5	"	
Totals	.....	.....	172	454	18.00	98980	73.66		

SUMMARIES

Total Miles	18.00	Per Cent of Time Spent on Road....	27.5
Total Tons Material Handled.....	49.49	Per Cent of Time Loading and Unloading	72.5
Total Ton Miles.....	73.66	Miles per Gal. Gasoline.....	2.82
Average Miles per Hour.....	6.27	Gals. Lub. Oil per 100 Miles.....	0.50
Total Gals. Gasoline.....	6.30		
Gals. Gasoline per Mile.....	0.35		

Note 1. Shipping department has traveling crane for loading trucks.
Note 2. Returned a different way to avoid street where repairing.
Note 3. Road good to A Street and railroad tracks, from there to foundry, dirt road muddy and in bad condition.
Note 4. Poor facilities for loading and unloading at foundry.
Note 5. One hour out for dinner.
Note 6. In delivering material to Concrete Material Co. it was necessary to drive to gravel pit, in backing out truck ran in the soft ground requiring 20 minutes to pry out.

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TABLE II

Log of 2-Horse Truck Demonstration. Name of Truck, ———. Weight, 4740 pounds. Remarks, ———. Date, April 28, 1914. Weather, Fair. Temperature, 70 F. Client, ———.

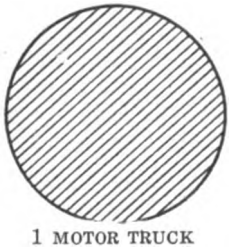
Depart		Arrive	Minutes						
Place	Time	Place	On Road	Loading	Miles	Load Lbs.	Ton Miles	Roads	Remarks
Shipping Dept.	7:00	7:16 P. R. R. Ft. House.	16	28	0.9	Mchy. 6300	2.84	Good Brick	
P. R. R. Ft. House.	7:44	7:53 C. & C. Ft. House.	9	42	0.2	Empty	...	"	
C. & C. Ft. House.	8:35	8:54 Shipping Dept.	19	27	1.1	Steel 4400.	2.42	"	
Shipping Dept.	9:21	9:51 H. V. Ft. House.	30	22	1.4	Mchy. 8100	5.67	"	
H. V. Ft. House.	10:13	10:23 B. & O. Ft. House.	10	38	0.6	Mchy. 1750	.51	"	
B. & O. Ft. House.	11:01	11:29 Shipping Dept.	28	24	1.25	Misc. 5600.	3.4	Repairing St.	
Stable	1:05	1:31 Forge Shop	26	43	1.3	Empty	...		
Forge Shop	2:14	2:50 Stock Dept.	36	54	1.4	Links 7100	4.27	Good Brick	See Note 1
Shipping Dept.	3:44	3:59 P. R. R. Ft. House.	15	38	0.9	Misc. 6600.	2.97	"	
P. R. R. Ft. House.	4:37	4:55 Stock Room	18	18	0.9	Plates 2600	1.17	"	
Totals .	.....	....	207	344	9.95	42450	23.25		

SUMMARIES

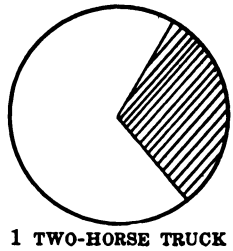
Miles per Hour	2.88	Total Ton Miles	23.25
Per Cent of Time on Road	37.6	Total Tons Material Handled	21.23
Per Cent of Time Loading and Unloading	62.4	Total Miles	9.95

Note 1. Poor facilities for loading at Forge Shop.

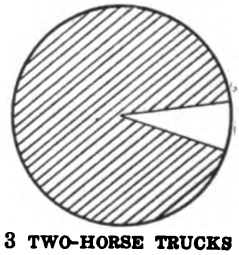
conditions); while the corresponding figure for one horse-drawn truck, during practically the same amount of time, is 23.25 ton miles. In the case of the three two-horse-drawn trucks this figure would be 69.75 ton miles. These results indicate that from the standpoint of material handled one motor truck has a slight advantage over the three horse-drawn trucks. This conclusion was further borne out by the results ob-



1 MOTOR TRUCK



1 TWO-HORSE TRUCK



3 TWO-HORSE TRUCKS

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tained from other demonstrations.

The preceding diagrams show a graphical comparison of the ton miles performed by the five-ton motor truck, one two-horse truck, and three two-horse trucks. The shaded area indicates ton miles.

In order to arrive at an understanding regarding the financial side of the question, a comparison of the initial investments, annual fixed charges, and operating costs is shown in Table III.

drivers and helpers will be dispensed with, resulting in an annual saving of $2,420 in labor alone. The data referring to the cost and maintenance of the horse-drawn vehicles are taken directly from the company's books and are therefore accurate. The initial investment for the horse-drawn equipment includes six horses, three wagons, harness, blankets, etc.

In Table IV is shown the daily cost of operation, the cost of operation per ton of material handled, the cost of

TABLE III

	Motor Truck	3 Two-Horse Trucks
Initial Investment	$4,800.00	$3,154.00
Fixed Charges		
Interest at 6 per cent	288.00	183.24
Depreciation of motor truck at 10 per cent exclusive of tires	480.00	
Depreciation horse equipment, Horses 12½ per cent, Wagons 10 per cent, Harness 20 per cent		358.50
Services of Veterinary		60.00
Insurance and Taxes	81.80	44.20
Total	$849.80	$645.94
Operating Costs		
Labor—Operator and Helper	$1,560.00	
3 Drivers and 3 Helpers		$3,980.00
Maintenance	312.00	378.00
Tires	360.00	
Gasoline	236.00	
Oil and Grease	57.00	6.00
Feed, bedding and shoeing		876.00
Total	$2,525.00	$5,240.00
Total Annual Cost	$3,374.80	$5,885.94
Annual Saving in favor of automobile truck	$2,511.14	

The above figures, then, denote a saving of $2,511.14 in the total annual cost of operation in favor of the motor truck; an annual saving that would more than pay the additional initial investment required for its purchase. This saving is largely made possible by the fact that, in the substitution of the motor truck for the horse-drawn equipment, two

operation per mile of material hauled, and the cost of operation per ton-mile performed by the motor truck compared with the horse-drawn equipment. The saving effected in each of these items by substituting the motor truck for the horse-drawn equipment is also shown.

Other advantages that would be gained by using the automobile truck

TABLE IV

	Cost per Day	Cost per Ton	Cost per Mile	Cost per Ton-mile
5 Ton Motor Truck	$10.82	$0.22	$0.60	$0.146
1 Two-Horse Truck	6.29	0.295	0.632	0.227
3 Two-Horse Trucks	18.86			
Saving by using Motor Truck	8.04	0.075	0.032	0.081

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in place of the horse-drawn vehicles are: saving in wear and tear of the shop floors and streets, greater cleanliness of same, less housing facilities required, thus permitting the greater part of the present stables to be torn down or used for other purposes, power driven auxiliary equipment on truck to assist in loading and unloading heavy material, and ability to make occasional long hauls not possible with horse-drawn equipment.

The investigation of the transportation conditions at the plant under discussion resulted in the following answer to the question submitted by the management: It will be materially to your advantage, both financially and otherwise, to substitute one five-ton gasoline motor truck for your present horse-drawn equipment consisting of three two-horse-drawn trucks.

FACTORS IN PURCHASING TRUCKS

When considering the purchase of a motor truck it is sometimes advisable to obtain from the dealers, or manufacturers, a list of the users of the different trucks which have been demonstrated, and send them a list of questions to answer along the following lines:

1. What is the capacity of your truck?
2. Do you find it necessary to operate the truck with a skilled mechanic?
3. What is the mileage obtained per gallon of gasoline and lubricating oil?
4. About how many miles a day do you drive the truck?
5. Over what kind of roads?
6. About what is the average load that you carry?
7. What mileage do you get from one set of tires? or, if not convenient to give this in miles, how long does one set of tires last in months?
8. Do you feel that for hauling of a heavy character the ——— truck is satisfactory?
9. Have you any comments or suggestions to make relative to the ——— truck that would be of assistance to a prospective purchaser at the present time?

From the answers to the above questions much valuable information may be obtained at first hand which will prove of considerable assistance in choosing between different makes of trucks.

In closing, attention is directed to an undesirable condition, almost universal, in the haulage of material. Too much time is spent at the terminals in loading and unloading, thereby reducing the earning power of the outfit.

Every transportation engineer understands the importance of keeping the equipment moving the largest possible per cent of time.

By referring again to Table IV, it will be noted from the summaries of the log that, while the speed and consequently the mileage of the motor truck is nearly twice that of the horse-drawn vehicles, the per cent of time actually spent on the road is less; and while it is not purposed to go into this matter in detail at the present writing, it is interesting to state that, although the material handled was of a very heavy character, certain recommendations—two removable nesting bodies handled by electric traveling cranes, and the installation of a light, self-powered jib crane on the truck—were made, which would result in the reduction of idle time by at least fifty per cent, thereby considerably increasing the earning power of the truck. The writer is of the opinion that the majority of cases offer similar opportunities for improving conditions and increasing the earning power of the equipment.

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RECORDING POWER PLANT OPERATIONS

By Julian C. Smallwood.

II. CO_2 RECORDERS, DRAFT GAGES, AND BLONCK EFFICIENCY METERS

Last month Professor Smallwood outlined the principles of recording devices and presented the general characteristics and mechanical construction of coal meters, water-flow meters, and steam-flow meters. Next month he will take up instruments for the recording of heat, pressure, and speed. A final paper will be devoted to the study of the records themselves.—THE EDITORS.

OF the two ways to investigate power plant efficiency—that is, measuring output relative to input, and measuring wastes—the second is the more satisfactory and direct. In the same way as counting the pennies takes care of the dollars, so measuring wastes provides for economy. It is always necessary to revert to a consideration of wastes to improve economy—to do so in the first place, therefore, saves steps.

Steam and water flow meters are invaluable for regulation, but they do not directly disclose sources of waste in the boiler room except when applied to measure leakage in pipe lines, blow-off, etc. Coal meter records taken with ash weights may be used to measure losses of combustible through grates, but this is comparatively a small item. Coming, then, to boiler recorders which directly detect wastes, of first importance are the CO_2 analyzer and the flue thermometer. The former, it should be remembered, is not alone an unfailing guide to efficient boiler operation; it has an eye only to the furnace and setting, and ignores the heating surface. The efficiency of a furnace delivering a high percentage of CO_2 is futile if the heat imparted to the ideal products of combustion is not transmitted through the heating surface as shown by a low flue temperature. Conversely, a low flue temperature does not alone indicate efficient operation unless accompanied by high CO_2 since it may be the result of a wasteful dilution of the furnace gases. To tell the whole story of boiler wastes (aside from grate losses and boiler leaks), the CO_2 recorder must be supplemented by a flue thermometer.

Although this combination makes an infallible aid to individual boiler and furnace regulation, measures economy, and also furnishes a record of the time and duration of cleaning periods, opening of doors, faithfulness and ability of the fireman, yet the CO_2 recorder has not in all cases given satisfaction. Some have objected that it is too delicate a mechanism; others, that firemen may cheat the instrument, avoiding scrupulous duty while maintaining flawless records. On the first score, one might just as well refuse to use a high grade watch. Both are delicate mechanisms; both need routine attention, adjustment, and a certain amount of familiarity to use successfully. The second fault may be due to incomplete installation. Owing to the expense of the instrument, it has been the custom to install only one for a battery of boilers. It then be-

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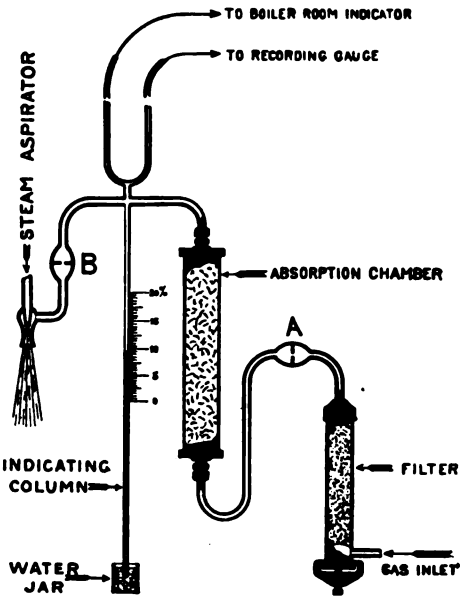

FIG. 1. DIAGRAM OF UEHLING CO_2 ANALYZER

comes a matter of following the line of least resistance for firemen to nurse the metered boiler and neglect the others.

CO_2 recorders give no direct information regarding boiler output. It is necessary for most economic plant operation not only to have each boiler develop maximum efficiency at its existing steaming rate, but also to establish the rate corresponding to maximum efficiency. Although it is not generally recognized, CO_2 and flue gas temperature records, taken with the rate of firing, yield a rough measure of the steaming rate. So long as the products of combustion are normal in temperature and amount, the ratio of weights of steam to coal is fixed; consequently, the more coal, the more steam. Approximate quantitative results may be figured under any conditions, if a proximate analysis of the coal is obtainable and if some assumptions be made as to minor losses, radiation, etc. This, however, is laborious, and although the method may be usefully applied for periods of several hours, averages of records being employed, it is neither practical nor precise for the purpose of hourly regulation. The steam flow meter admirably serves the purpose of adjusting boiler output, but to use it with a CO_2 analyzer in part, duplicates their service since each is used to measure economy. There remains, then, for this purpose, an instrument which does not

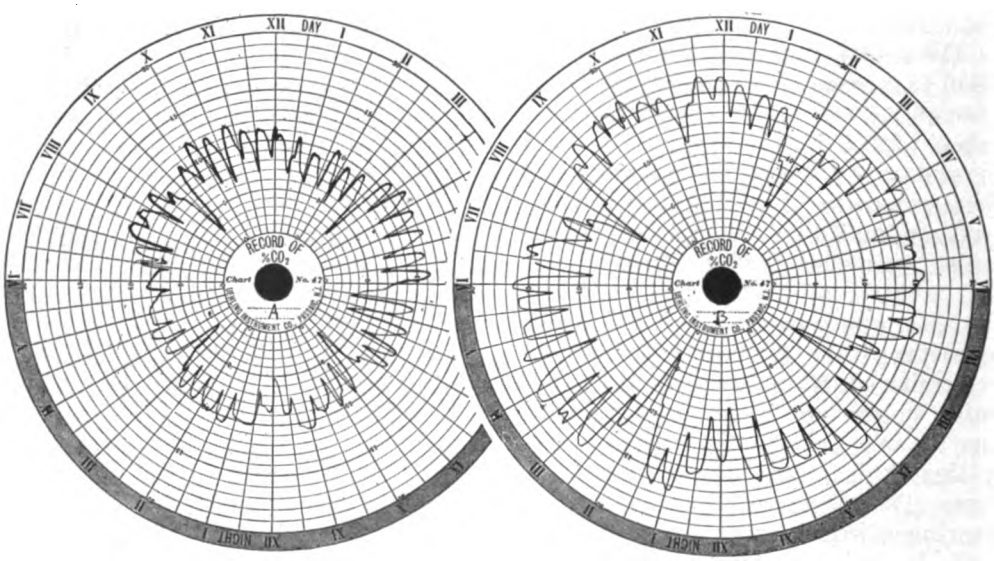

FIG. 2. RECORDS FROM UEHLING ANALYZER

Chart A shows an average of 8.45 per cent CO_2. Chart B, 13.2 per cent CO_2.

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duplicate the service of others, which is simple and comparatively inexpensive, and which may be had, in some makes, combined with the CO_2 recorder; namely, the draft gage. This will be given attention later; in the meantime let us consider the different types.

CO_2 RECORDERS

These recorders may be divided into two classes, continuous and intermittent. Of the former, a conspicuous one, on account of its simplicity, is the Uehling recorder. The principle of this instrument is shown by the diagram, Figure 1. A steam aspirator draws flue gas through the two orifices *A* and *B*, between which is a special, dry absorbent of CO_2. If no CO_2 is present, there will be a definite pressure, below atmosphere, between the two orifices. If CO_2 is present, it is absorbed between the orifices, reducing the volume of gas in this space and thereby decreasing the pressure. Pressure thus becomes a measure of CO_2 removed, and is recorded by a low pressure gage (Figure 3) calibrated in percentages of CO_2.

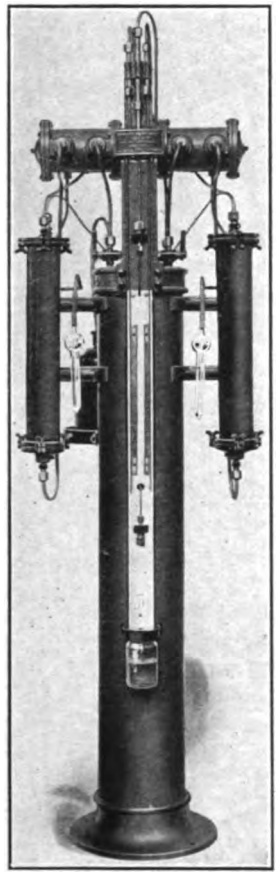

FIG. 3A. UEHLING CO_2 ANALYZER

This instrument is made in two, three, and four multiple units, and with flue thermometers in combination. The reagent is easily replaced. The recording apparatus is simple, admitting of no derangement except from leakage. Friction of the recording apparatus is at a minimum since it consists only of pen on paper, the operation being on the principle of Figure 13.

Figure 2 is a pair of records from a hand-fired boiler; the one on the left represents the old conditions of combustion taken shortly after installing the recorder, and the one on the right shows the improvement brought about — a gain, roughly, of ten per cent. These charts show very clearly the times of cleaning fires and of firing.

FIG. 3B. UEHLING CO_2 RECORDING GAGE

The Parker CO_2 recorder, lately placed on the market by the Precision Instrument Co., presents some desirable features. The analyzer is shown by Figures 4 and 5. In principle it resembles somewhat the Uehling machine. Briefly, it consists of two motor-driven rotary gas pumps, one of which delivers flue gas at a definite rate to an absorption tank, while the other withdraws and discharges the flue gas at an equal rate. If the volume is lessened by the absorption of CO_2 there results a diminution of pressure in the gas handled by the

FIG. 3C. BOILER FRONT INDICATOR

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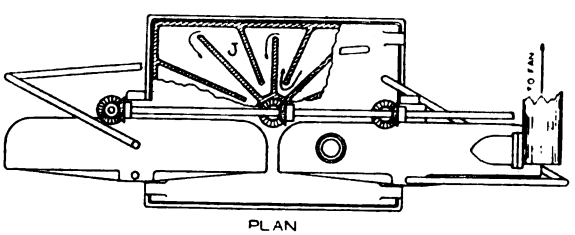
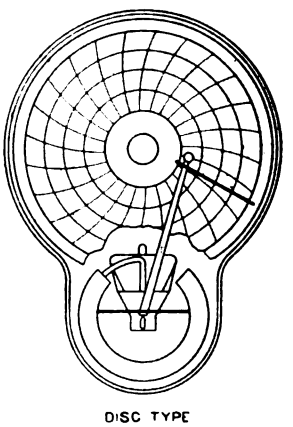
second pump; this diminution is proportional to the CO_2 absorbed. The pressure of the gas in the second pump is transmitted to a low-pressure recording gage (Figure 6) calibrated in terms of CO_2 percentages.

Details of the construction and operation may be studied in Figure 4. The pump on the right of the elevation admits the passage of a continuous stream of flue gas above the oil seal; this stream is maintained by a fan. The pump buckets entrain a portion of the gas continuously and deliver it to the absorption tank underneath, in which caustic potash is used as a reagent. The discharge pump on the left is of the same size as its mate and runs at the same speed.

This instrument is made in single and multiple units up to six. One of its good features is the recording mechanism (Figure 6) which is arranged to give multiple records on a 60-day chart, an eight-hour period of which is exposed. Another desirable feature is that a large sample of flue gas is handled by the fan, of which only a small and necessarily representative part is delivered by the pump for analysis.

The Simmance-Abady analyzer and recorder, Figures 7 and 8, is an example of the intermittent type. Briefly, its operation is as follows.





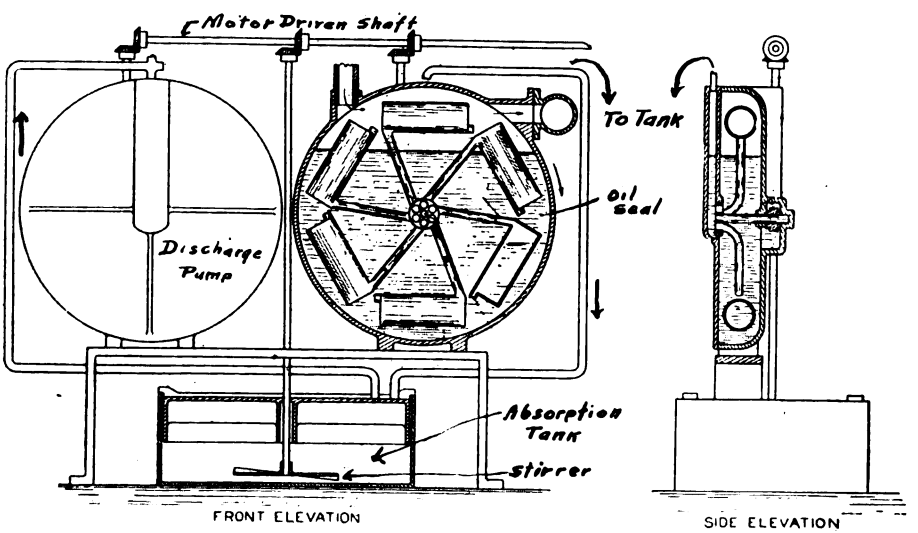


FIG. 4. PLAN AND ELEVATIONS OF PARKER CO_2 ANALYZER, AND PLAN OF DISC TYPE RECORDER

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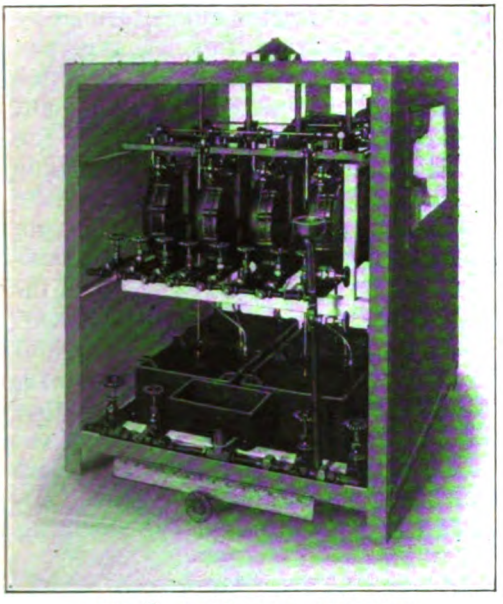

FIG. 5. PARKER CO_2 ANALYZER

Referring to Figure 7, the water-sealed meter tank on the left alternately draws in and discharges a definite volume of flue gas by means of the rising and falling meter bell. This gas is delivered to the absorption tank, shown at the bottom of the figure, from which it is forced by the downward stroke of the meter bell into the recorder tank on the right, raising the counter-balanced recorder bell to a height proportional to the final volume of the gas. The last position of the recorder bell is therefore a measure of the CO_2 absorbed from the sample, and this measure is translated by the recorder pen.

The motive power of the apparatus is derived from water. A water aspirator at the top of the machine (Figure 7) maintains a continuous stream of flue gas through the sampling pipe. The aspirator water then descends into the middle or siphon tank and raises a float. This float is connected with the meter bell which falls as the float rises. When the tank is full the water is quickly siphoned out; the float descends, and the meter bell rises and draws a charge of gas. The water falls into a pot below the siphon which in its descent closes the control valve in the gas inlet pipe. This water is then emitted and allows the valve to open again. The recorder pen is released by the action of the pot and an unbalanced weight causes it to travel until checked by a stop which bears on the recorder bell in its final position.

Another form of this instrument produces rectilinear instead of circular records. Still another is combined with a draft gage which is situated at the top of the case and registers on the same chart with the CO_2. Figure 9 is a reduced facsimile of a pair of records.

The operation of this machine has been told in some detail (although not fully) because it is illustrative of in-

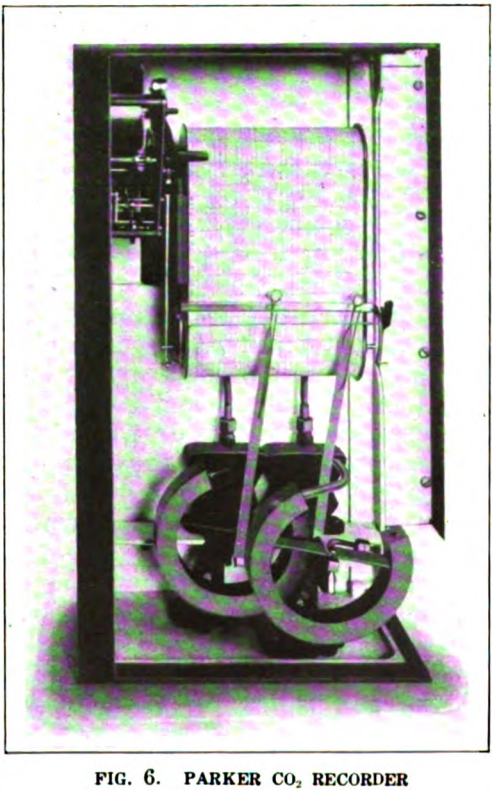

FIG. 6. PARKER CO_2 RECORDER

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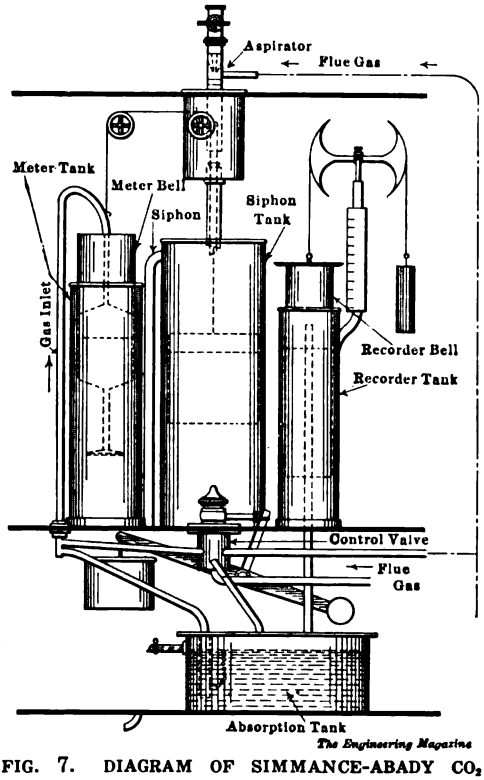

FIG. 7. DIAGRAM OF SIMMANCE-ABADY CO_2 ANALYZER

termittent water-driven analyzers in general. The sequence of operations of the two following recorders will therefore not be given.

In the Sarco Engineering Company's product, Figure 10, the functions of measuring off a sample and delivering it to a potash solution is performed by a water aspirator and a system of siphons and tubes. In this case, the charge is drawn in by a falling column of water, thus dispensing with one float. The reduced volume is applied to raise a bell to which the pen arm is connected. The full stroke of the pen, corresponding to maximum displacement of the bell and undiminished gas volume, registers zero CO_2; in general, the stroke of the pen is less as the CO_2 increases. Figure 11 shows the resulting form of record which may be integrated and averaged by running a planimeter along the curve formed by the upper extremities of the pen strokes. This record is obtained from an older type of the instrument than the one illustrated. With the latest type the pen strokes are made from the top downward, so that the percentage of CO_2 is measured from the base as a datum; a more convenient arrangement for reading and integrating.

An installation of the Hays CO_2 and draft recorder is shown by Figure 12. An essential difference between this and the other two intermittent recorders, just described, lies in the fact that the final volume of gas is applied to compress air. The resulting

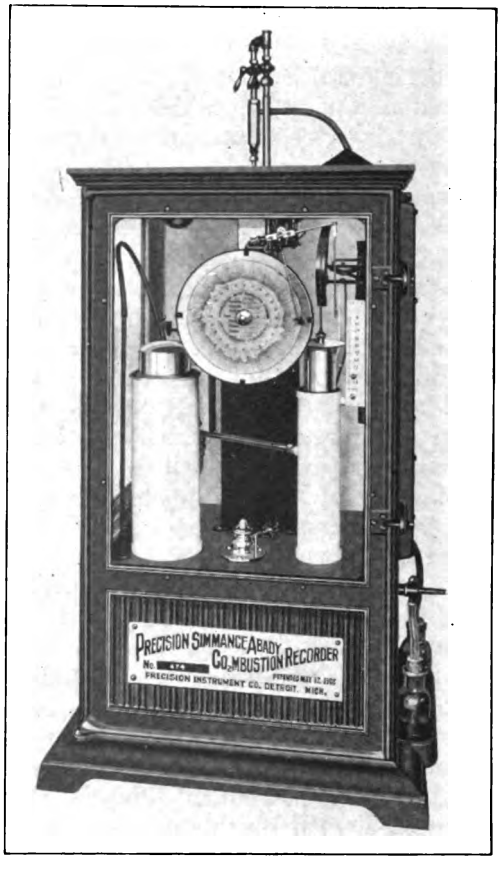

FIG. 8. SIMMANCE-ABADY ANALYZER AND RECORDER

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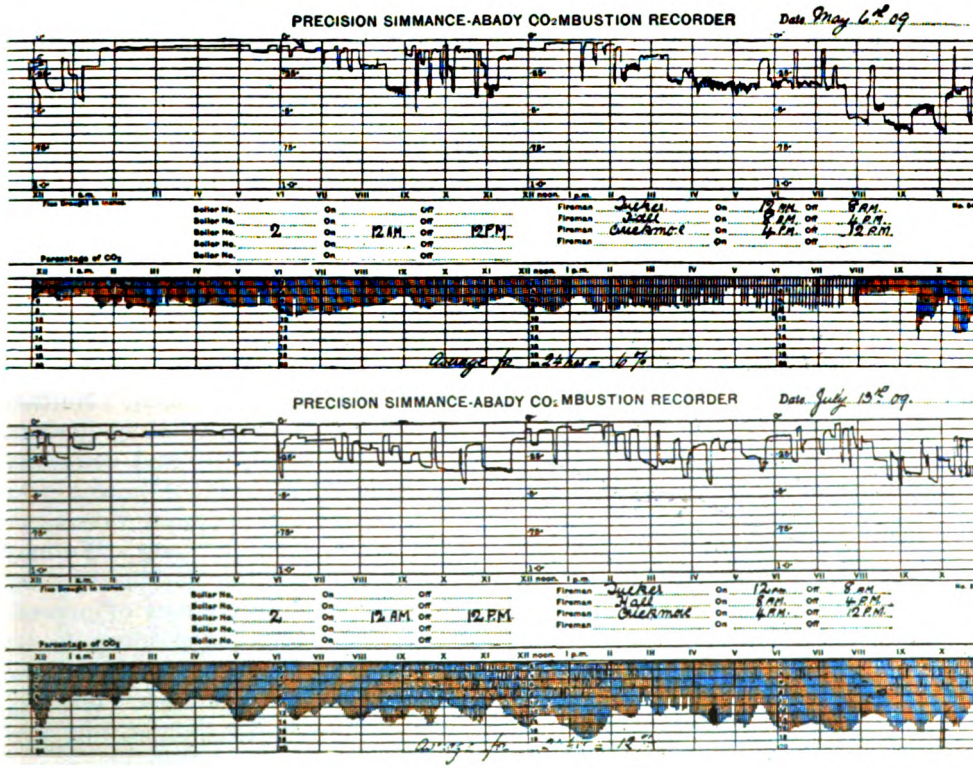
PRECISION SIMMANCE-ABADY CO2MBUSTION RECORDER
Date May 6th 09
PRECISION SIMMANCE-ABADY CO2MBUSTION RECORDER
Date July 13th 09.

FIG. 9. SYNCHRONOUS RECORDS FROM SIMMANCE-ABADY RECORDER OF DRAFT AND CO_2
The chart for May 6, shows 6 per cent CO_2; that for July 13, 12 per cent, or a saving of 15 per cent.

pressure is recorded by a low pressure gage. In this way the use of floats is avoided entirely. Draft and CO_2 are recorded on the same chart.

Comparing these various types of recorders it will be noted that the first two and the last admit of a separation of the recording apparatus from the analyzer and the possibility of installing indicating instruments at the boiler fronts while the recorders themselves may be placed in the superintendent's office. A further advantage is that the analyzer may be located at a place of uniform temperature free from dust, and where the charts may be conveniently replaced. In the general principle of smoothness of action the continuous machine is preferable to the intermittent, but, so far as the resulting records and their integration are concerned, there is little choice. Each of the recorders described has some special features to recommend it, which space forbids touching upon.

Regarding the question of satisfactory and proper metering equipment, if CO_2 recorders (with flue thermometers) are depended upon for boiler regulation and waste measurement, without the accompaniment of steam, water, or coal meters, each boiler should be supplied with its own analyzer. This fact is being recognized nowadays by the introduction of multiple-unit instruments. If steam or water and coal records are fully kept, then one or two CO_2 recorders to a battery of boilers will be sufficient if arranged so that any flue may be quickly connected with the recorder. Then, when a boiler or operative shows a falling off in performance,

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the conditions may be quickly analyzed and remedied.

Coming back to the case where steam or water flow meters are not used, it has been previously mentioned that an additional instrument, the draft gage, is desirable. In the present state of the art I should not like to be understood as advocating few recording instruments; yet right here it may be well to emphasize the fact that a *fireman* runs the boiler—not an analytical chemist—whose capacity to observe and interpret is limited. From time immemorial he has had a water column and a pressure gage upon which to keep a watchful eye; add to these a flue thermometer, a CO_2 recorder, and a draft gage, then we can hardly expect him to shovel coal between times. Neither can we expect the ordinary fireman to form an intelligent and deductive knowledge of records; if he could he would not be the ordinary fireman—or a fireman at all for long. We may install a CO_2 analyzer and instruct the fireman in certain courses of procedure to be followed according to its indications. This is not beyond the scope of his ability or time. We may install a flue thermometer, but this should be for the information and guidance of the chief engineer. Finally, we may equip each boiler with a draft gage and instruct the fireman what draft to carry at a predetermined constant steaming rate. With boilers under a swinging load it may be of some benefit for operatives to express the draft in terms of inches of water, instead of number of links of the damper chain or number of turns of the blower valve, but the interpretation of and action upon the precise

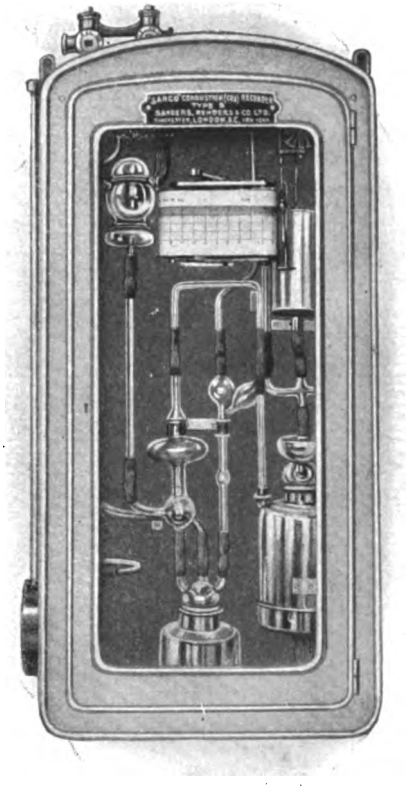

FIG. 10. SARCO CO_2 ANALYZER AND RECORDER

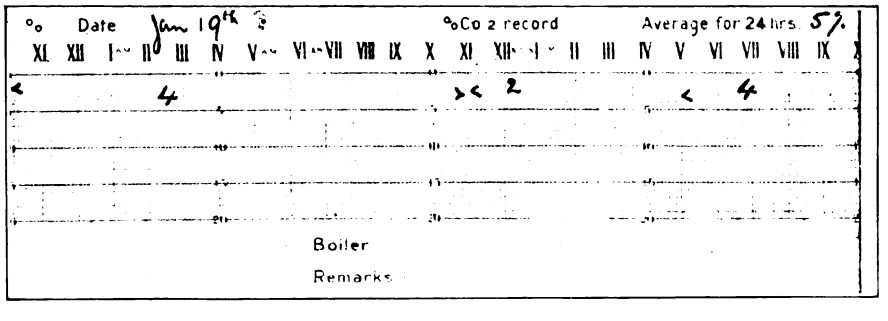

FIG. 11. RECORD FROM SARCO CO_2 ANALYZER

The record, shown by the faint vertical lines, is in red on the original chart. This record gives an example of poor furnace operation.

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measurement of draft should be left to the chief engineer. The gist of this digression, then, is this: Although it is desirable and necessary for complete data to use several different metering instruments, the fireman should be obliged to use only one of them, or at the most two, for the purpose of regulation and maintaining efficiency. As for the others, he may be encouraged to read and understand

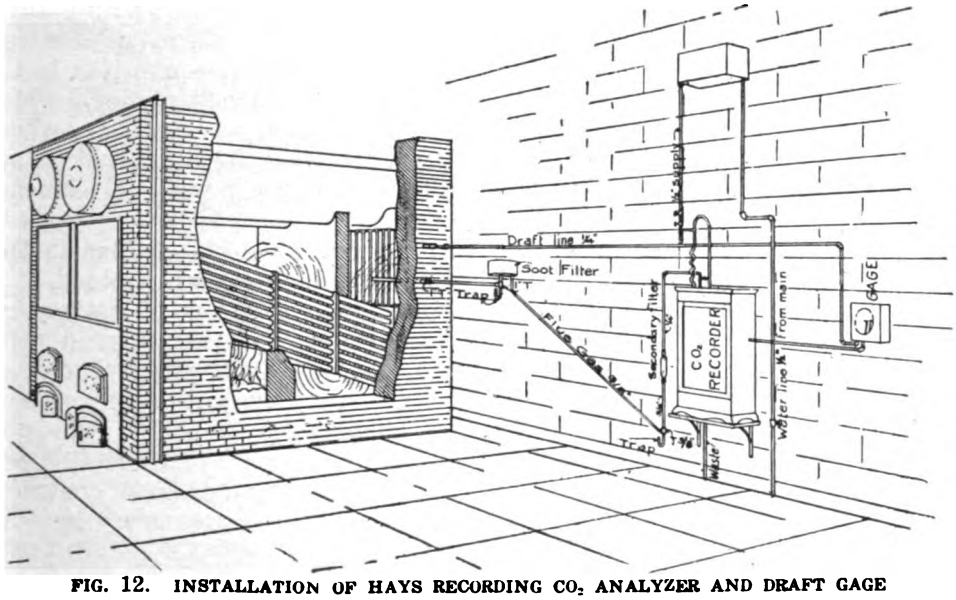

FIG. 12. INSTALLATION OF HAYS RECORDING CO_2 ANALYZER AND DRAFT GAGE

them, but not to act upon the records —this should be left to a more highly trained intelligence.

RECORDING DRAFT GAGES

The general subject of draft as related to steam boiler practice is one whose laws have not yet been thoroughly formulated; and the relations between it and steaming rate, products of combustion, fuel bed thickness, etc., are by no means simple. In spite of this a knowledge of the normal draft corresponding to best output and efficiency enables one to make useful deductions when the draft is abnormal.

Total draft should be recorded and studied in its components, namely, the pressure drops through the furnace and through the boiler. Of these the furnace has a variable surface resistance due to different thickness of fuel bed, and the boiler a constant surface resistance (when in good condition). If the steaming rate is increased, both furnace and boiler resistance must increase; the former because of added surface and gas velocity over it, and the latter because of increased velocity. This, of course, applies to good operating conditions. A hole in the fire will decrease the furnace drop and a heavy bed of clinkers or ash increase it; while a fallen baffle or a soot choked passage will have like effects upon the boiler resistance. But, if the CO_2 percentage remains high, an increase of furnace resistance, shown by the draft through the fuel bed, is always accompanied by an increase of capacity; hence the draft through the fuel bed is a relative measure of capacity. The relation is not a simple one as the rate of steaming and draft advance according to the different conditions imposed by the size of fuel, design of

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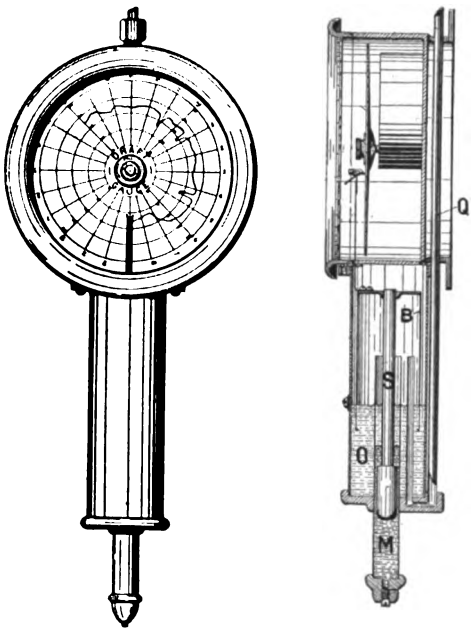

FIG. 13. UEHLING DRAFT RECORDER

boiler and furnace, etc. However, it remains that the draft through the furnace is an indication of furnace output, other conditions being normal as shown by the CO_2 recorder.

The draft across the heating passages may be referred to instead of a flue thermometer since the condition of the surfaces may be thus ascertained. This, however, necessitates a knowledge of what is the normal draft through this part of the boiler, which depends upon the steaming rate.

The total draft of itself is of little significance; it varies not only with output but with the condition of the gas passages in the boiler. The useful draft to record, then, in connection with CO_2 analyses and flue temperatures, is that through the furnace.

Figure 13 shows the Uehling draft recorder applicable to natural draft. It consists of a bell, *B*, supported on a stem, *S*, which floats in a mercury container, *M*. The bell is sealed with oil, *O*, and is subjected internally to the flue pressure by connection with the tube *Q*. As the pressure of the atmosphere is greater, the bell descends until the buoyancy of the mercury establishes equilibrium. The drop of the bell is thus in direct proportion to the draft. A pen attached to the bell makes the record.

A modified form of this instrument, of the differential type, may be used for forced draft or for measuring the drop through the boiler with natural draft. The modification consists chiefly of a second connection to the space above the bell through which the lower of the two pressures whose difference is to be measured is admitted. The mechanism is commendable in that there is no link work to become deranged, no springs to lose stiffness, and friction is avoided.

This instrument is of rather unusual design, and resembles in prinsiple the Kent draft gage. The usual low-pressure recording gage works on the diaphragm principle, the diaphragm being part of a metallic bellows which expands and contracts with changes of pressure (see Fig-

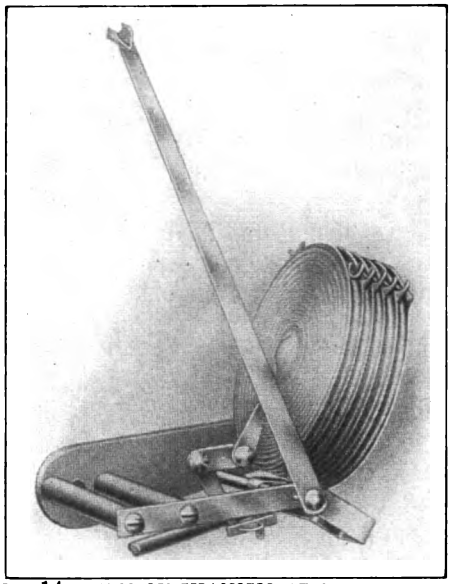

FIG. 14. PEN MECHANISM OF FOXBORO LOW-PRESSURE RECORDING GAGE

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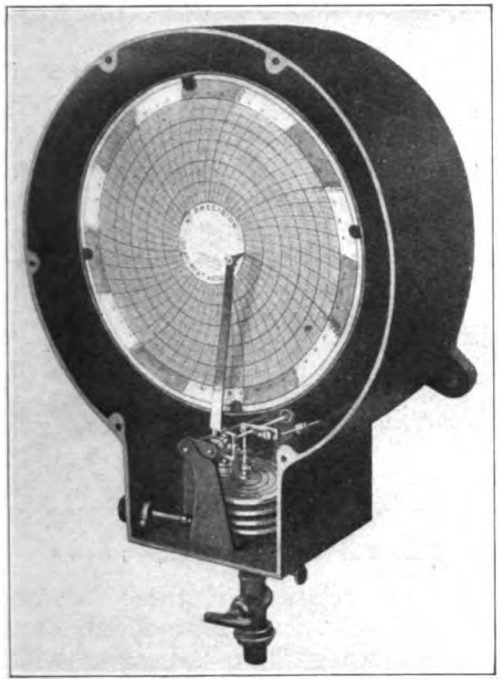

FIG. 15. PRECISION LOW-PRESSURE RECORDING GAGE

ure 14). It is on this principle the draft gages of the Blonck (so-called) efficiency meter operate, Figure 18. If it is arranged that the outside of the bellows is subjected to one pressure and the inside to another, then the mechanism becomes a differential gage.

Figure 15 illustrates another instrument of the diaphragm type applicable to draft measurements.

BLONCK BOILER EFFICIENCY METER

This instrument is an ingenious combination of draft gages which, however, is misnamed in that it does not measure efficiency, but, instead, enables the fireman to get the best efficiency. It is based upon two assumptions, namely:

1. That there is a directly proportional relation between boiler or furnace draft and steaming rate when the best operating conditions obtain.

2. That in any boiler using a given grade of coal, there is a constant ratio between boiler and furnace draft under the best operating conditions.

Regarding the first of these assumptions, the researches of Messrs. Ray and Kreisinger* seem to contradict it, in that they indicate that the pressure drop through the boiler proper varies as the square of the weight of the products of combustion. Along that part of the working range of a boiler within which the efficiency varies but little, the weight of the products of combustion is very nearly in direct proportion to the steaming rate, consequently the drop of pressure varies as the square of the steaming rate within this range. This, however, is not an important point in that the first assumption is made for the purpose of estimating capacity and does not bear on the regulating function of the instrument, which is the primary one.

To substantiate the second assumption, the curves reproduced in Figure 16 are cited by the Blonck company. These show a parallel advance of boiler and furnace drafts, being plotted to different scales, and are for best efficiency at each load. This being true, if at any load there exists a draft other than those shown by the curves then the efficiency is less than maximum. The causes of such de-

* Bulletin 367, Bureau of Mines.

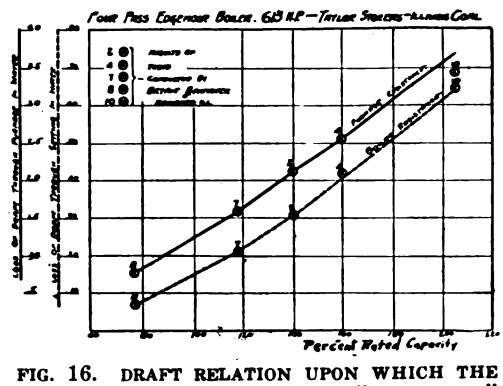

FIG. 16. DRAFT RELATION UPON WHICH THE PRINCIPLE OF THE BLONCK "EFFICIENCY" METER IS BASED

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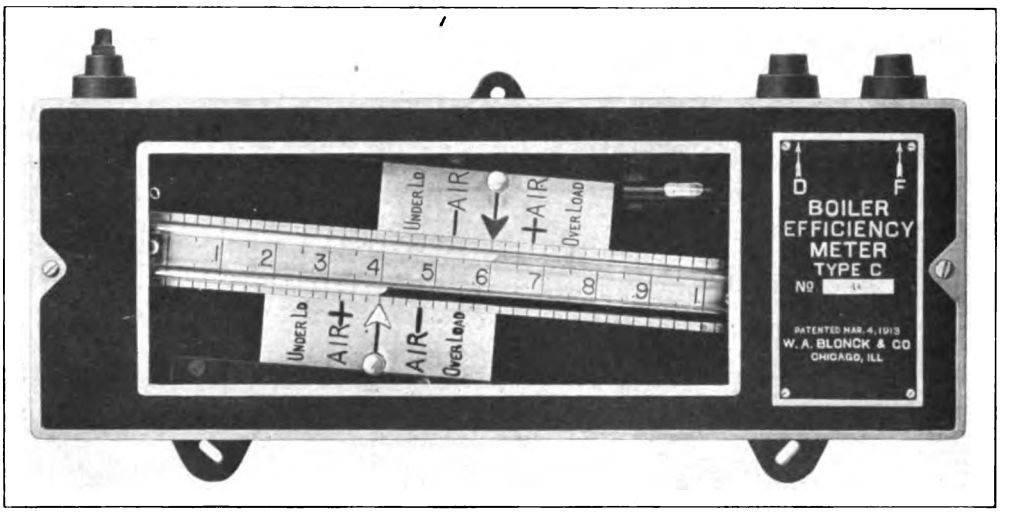

FIG. 17. INDICATOR OF BLONCK "EFFICIENCY" METER
The lower gage is filled with red oil, the upper with blue.

viation from the ideal may be deduced from the direction of the deviation. For instance, if the furnace draft is low and the boiler draft high, excess air is denoted; the reverse condition, lack of air, or a thick fuel bed, etc.

Now, if two draft gages are constructed so that the indicator of one has five times the motion of the other (which is the ratio of scales of the two drafts in Figure 16) then the graphical relation of these curves may be mechanically reproduced. For best efficiency these indicators will advance in parallel as the load increases. This is accomplished with the Blonck indicating apparatus as shown in Figure 17. To get the proper ratio of movement of the indicating liquids, the cups forming the right legs of the U-tubes (not shown) are made of different diameters; con-

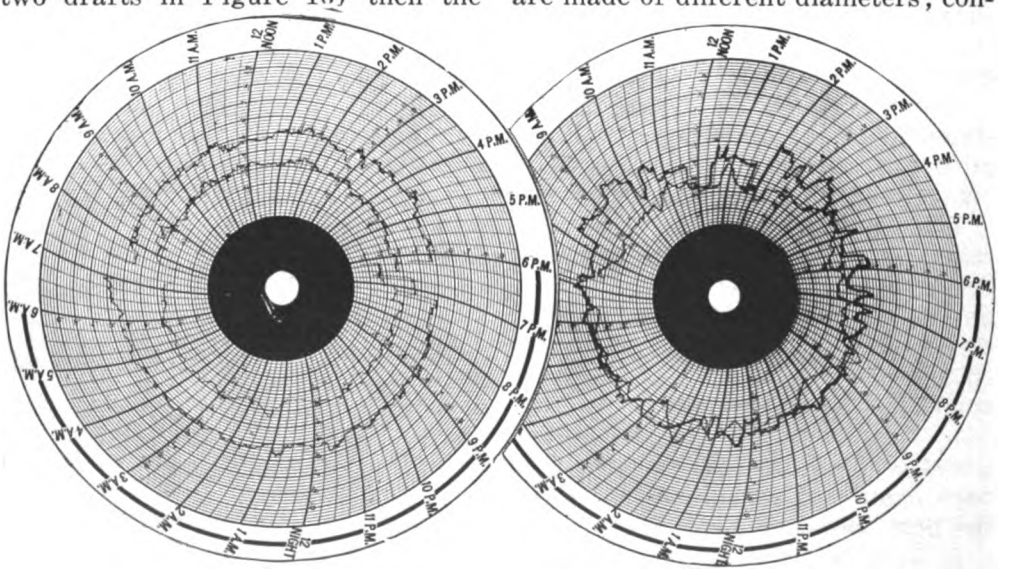

FIG. 18. BEFORE AND AFTER RECORDS FROM BLONCK METERS

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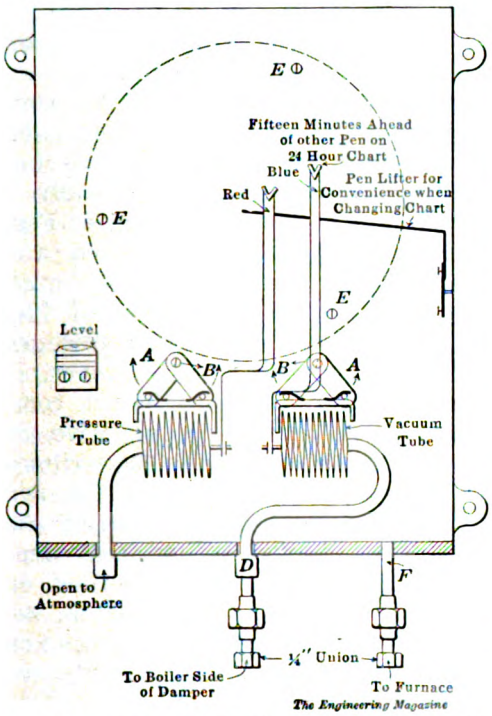

FIG. 19. RECORDER DRAFT GAGES OF BLONCK METER

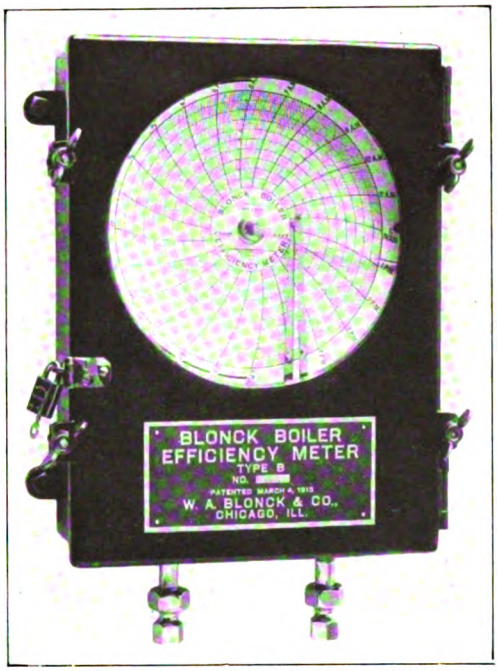

FIG. 20. BLONCK METER RECORDER

sequently the liquid in one of the gages requires greater draft, in definite ratio, to move it a given amount on the slanting scale. The reading of one of the gages must, therefore, be multiplied by a constant, if actual quantitative values of draft are sought.

Before it may be fully used the instrument must be set as follows: The boiler, furnace, and setting must be put in the best condition possible, and then the boiler must be operated under best efficiency, as shown by a CO_2 analyzer, at its average load. When this is established, the pointers of the draft gages (Figure 17) should be set at the drafts indicated and left there. This fixes the ideal drafts at average load; at any other load there should be the same linear distance between the surfaces of the indicating liquids as denoted by the pointers.

The recording apparatus (Figures 19 and 20), is similar in its fundamental principle to the indicating apparatus. The datum setting is obtained in the same way and located by concentric lines on the chart. The pens should then travel always with a constant difference between them for best efficiency. The fireman may quickly learn by following a few simple rules how to maintain the condition illustrated by the results of Figure 18.

It should be noted that the future truthfulness of this device depends upon the continued use of the same grade of coal, if this is changed the instrument must be reset; consequently, a plant fully installed with these combination draft gages should also be equipped with a CO_2 analyzer for occasional checking.

It should further be noted that the ratio of five to one between the drafts plotted in Figure 16 applies to this boiler, but to another boiler a different ratio may apply, requiring a combination of draft gages of differ-

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ent proportions. The manufacturers meet this objection by supplying a number of such different combinations.

Quantitative results of economy or capacity are not to be had from the use of this instrument except, by inference, under the one circumstance that the drafts obtained during test be duplicated. When the drafts bear the proper relation to each other at under-load or over-load, we may infer that the best efficiency is obtained at that load, but not what that efficiency is. We may gather some idea of the steaming rate under the same circumstances, but if the relation between the drafts is abnormal, we can form no idea at all of what is being lost in the way of economy and output. In these respects the Blonck device is inferior to the CO_2 and flue temperature recorders, for these furnish data by which exact saving or losses may be figured under any conditions. On the other hand, the Blonck recorder is comparatively inexpensive to install and maintain; its indications are readily utilized by firemen; it is simple in construction; it is compact, and what story it has to tell, it tells immediately and plainly. Personally, I should like to have the curves of Figure 16 thoroughly generalized and ratios of draft well established for all types of boilers and grades of fuel before placing unbounded confidence in draft gages alone. However, it must be stated that the Blonck combination is certainly productive of results; cases brought to the writer's attention show as much as ten per cent saving through the use of the device as indicated by coal and switchboard records. Whether or not this type of instrument is selected for boiler regulation instead of other instruments will possibly remain a matter of individual choice rather than of intrinsic superiority.

To be continued

SCIENTIFIC MANAGEMENT FOR THE FACTORY OF MODERATE SIZE

By Dwight T. Farnham

In a small plant Mr. Farnham developed a Superintendent—Staff, Assistant Superintendent—Line organization which enabled the superintendent to break away from routine clerical labors and gave him time to study and improve operations.—THE EDITORS.

THE factory employing from a hundred to three hundred men is frequently owned by a single individual, or, if the company is incorporated, the management is donimated by the heaviest stockholder to such an extent that the result is the same. This man may not be actively engaged in the business of manufacture—quite frequently is not—but nevertheless his influence is strongly felt in matters touching the general business policy, expenditures, and innovations of any sort.

The manager of the business, who may or may not have had manufacturing experience, is often the sales manager, in fact, if not in name, and presides over the general office of the company. He is looked to for results, but must keep well within the limits of the company's policy as laid down according to the doctrines of the dominant stockholder, and heresy of any

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kind on his part is likely to result in personal disaster.

One of the most firmly established tenets in the creed of the successful business man is that of insisting upon the utter extermination of unproductive labor. No one will dispute the soundness of the reasoning provided the labor so designated assists in no way the process of manufacture. Too often, however, since the man whose brain only is active differs not greatly in appearance from the man who is loafing, the fact that an employee is neither rushing about nor actively engaged in manual labor causes him to be condemned as useless, and he is henceforth abolished. The heavy stockholder very often knows a good deal about bookkeeping, and, since he visits the factory to better it, he will readily attack any apparent excess of men in this department, while fear of showing his ignorance would cause him to hesitate a long time before criticising the number of men actually engaged in the work of manufacture. The manager and the superintendent must please their superior and so are extremely loth to sanction in any way an increase in "apparently unproductive labor." When lack of profits force retrenchment the clerical force is always the first to be attacked, and the efficiency of the executive is often badly impaired by the consequent lack of necessary figures. Even some very successful business men go so far as to view with great alarm the acquisition of anything in the nature of office furniture by a superintendent, fearing that he may be tempted to loll in idleness when he ought to be rushing about among his men. They feel that they are getting their money's worth when he is wearing out shoe leather which he pays for, but they are not so sure of it when he is sitting at a desk working his brains and using paper and pencil which they pay for. This may seem to be an exaggeration, but nevertheless the two commonest criticisms applied to managers and superintendents are, "the business is too top heavy," or, "he has too many men standing around."

Difficulties of Introducing Scientific Management

Human nature being what it is, and the successful owner having pretty definite ideas as to who is responsible for his success and as to just how it was obtained, what chance has the efficiency engineer of foisting upon the average small business the paraphenalia of Staff and Line, Routing, Dispatching, and Time Study, with their Chief of Staff, Supervisors of Study, of Planning, of Standards, of Bonus, of Analysis, etc., together with each one's clerks, messengers, etc.? The result of such an attempt would be too awful to contemplate. How then is the small or medium-sized enterprise to obtain the benefits which can unquestionably be obtained by the introduction of the principles of efficiency?

Evolution of the Superintendent (Staff) Assistant Superintendent (Line) Idea

In 1906 the writer was placed in charge of a factory in the Far West which employed a hundred men. The plant was in a chaotic condition, having just passed through an interregnum under a foreman after a year under a superintendent whose troubles had driven him to drink. The old timers in charge of various departments were at war with each other; each had designs upon the superintendency, and all looked upon a college graduate as some sort of an animal designed rather to amuse than to alarm. As a result, the writer spent the first few weeks in rushing about from one department to another trying to get each one patched up to

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run long enough so that the factory could be operated as a whole. When this had been accomplished the factory was limping to such an extent that it was realized that each department and each material would have to be analyzed and great improvements made before anything like efficient operation could be looked for. Meantime the factory had to be run and it took all of one man's time straightening out the snarls arising in each department and keeping the product coming. This forced the writer to recognize the principle that *the factory should be so organized that it would run itself, leaving the superintendent free to throw himself to the aid of the weakest department.*

APPLICATION OF THE PRINCIPLE

This idea was worked out in practice by gradually evolving from the most promising material at hand a line organization under an assistant superintendent. This organization handled all the routine operations of manufacture leaving the superintendent free to meet any emergency of an extraordinary nature and to do analytical and research work—made him in a measure chief of staff. It seemed logical that the highest salaried official about the plant should be best able to study and improve the various operations, and the opportunity to do this was secured. When necessary, assistants were detailed from the different departments, and the scope of certain foremen who were expert in certain operations was extended to cover other departments as far as these operations were concerned. The course of the product through the factory was studied and changes made which facilitated its movement. The assistant superintendent made the dispatching one of his duties, and a sufficient supply of raw and semi-manufactured material was assured each department. Processes were studied and unnecessary labor eliminated. All finished products not strictly first quality were classified according to their defects and the causes removed as far as possible. The written instruction card was adopted for the most important operations after a thorough analysis and determination of the best method by a process of elimination. Outside expert assistance was called in when necessary; other plants were visited, and the experience of the best workmen made available. Machines were improved and in some cases new varieties were substituted. This type of staff organization, as will be seen, permits the careful investigation of various problems, but at the same time, on account of its great flexibility, its expense is no greater than the occasion demands.

GENERAL RESULTS

As the system began to operate more smoothly, the results were evident. Fuels were investigated, and a more efficient type of furnace reduced power costs. By the use of indicator diagrams, power was increased and steam consumption decreased. Gages recorded the conscientious performance of the duties of the night crew. Shutdowns on the more important machines were diminished when recording gages were installed which showed their duration and frequency. Technical control on all furnace operations saved fuel and improved quality. Conveying and unloading plants were installed which cheapened the cost of handling raw materials and fuel. Methods were adopted which lessened the damage to parts in transit from one department to another. Staff methods of investigation applied to every department decreased costs and improved quality.

For the first few months it was impossible to determine the exact bal-

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ance of the plant as the maximum output for each department was not known. As soon as this could be ascertained, however, weak departments were strengthened by the addition of equipment, men, or special attention, until a continuous pull was exerted upon the product throughout the course of its movement through the factory. The way some departments expanded when cramping conditions were removed was astonishing. As a result, responsibility for delays was placed where it belonged, and the output of the plant was increased nearly fifty per cent.

The cost system was overhauled, useless work eliminated, and the balance so arranged as to emphasize variations from the normal in such a way that they would receive immediate attention. The cost of vital or governing operations was figured daily, so that the executive knew each morning what efficiency had been attained the day previous. The shipping department was reorganized along lines which would make mistakes difficult; and the hundred and fifty thousand dollar stock of manufactured goods which it was necessary to carry was recorded on a continuous card inventory in such a way that the office knew the supply of each variety at all times and, therefore, could safely promise delivery or manufacture new stock to remedy deficiencies. The time of all workmen was distributed against the proper operation, so that prompt and reliable records were secured. All clerical work was so systematized that, with the exception of the formal bookkeeping, it could be done by one man in spite of the fact that sales usually amounted to over $400,000 per year.

Labor conditions were improved as time went on. About three-quarters of the men were paid by the day and the balance were under the task system. Good results were obtained with the latter as the time allowed for the tasks was never cut, although one or two adjustments had to be made in the rate per hour to suit conditions in the district. The efficiency of the day workers, of course, depended largely upon the driving ability and personality of the foremen, but everything was done to remove obstacles to rapid performance and to make working conditions comfortable. Definite records were kept of the daily production of each man or crew, so that any urging to further efforts were as intelligent as is possible under the day labor system.

Wherever possible it was made easier to do the right thing than the wrong, and it was generally so contrived that the persistent wrong doer was sooner or later "hoist with his own petard." The adoption of this principle, while it requires absolute fairness, a knowledge of human nature and some intuition, elevates the general tone of an organization to a marked degree, as apparent Fate is a much more terrible opponent than the usual flesh and blood boss.

Every effort was made to get the workmen to tell the truth when a fault resulted in loss, on the theory that if all the causes for a defect were known the defect could often be remedied or the reason for the mistake or shortcoming of the workman intelligently removed, while if some factor were concealed wrong conclusions would be reached. In fact in one or two departments the workmen knew that a lie meant instant discharge, while the most flagrant offense if honestly explained meant, at the most, a lay-off. This resulted in a mutual trust and frankness between the executive and the workmen, which were of incalculable value.

The adoption of this system of

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Staff and Line organization cut the labor cost in less than two years from twenty to thirty per cent, and increased the output fifty per cent and the quality twenty per cent.

Further Application of the System

After a few years the system was installed by the same company in its other factories. In one, the introduction of the system allowed the superintendent sufficient time to exercise a latent inventive genius which revolutionized a considerable branch of manufacture. The output of one machine which had never in the history of the business exceeded 5,000 units per day was increased to 13,000 with little increase in the operating crew. All sorts of articles were manufactured which had been impossible before and great improvements in quality were made. The company became possessed of a number of valuable patents; workmen were rewarded for their inventive genius, and ingenuity was stimulated.

Record outputs for various machines and quality records were circulated among the different factories, and successful emulation was rewarded. Output increased, quality improved, and costs decreased. The best brains were released from routine and the results were of incalculable value to the company.

In all, this system was installed in six different factories, and the invariable result was lower costs, increased output, and improved quality. Later it was successfully adapted to the operation of mines and quarries; always with beneficial results.

Application of Scientific Management Through the System

In 1911 the principles of Scientific Management were definitely stated in book form by Taylor and Emerson. Their importance was immediately apparent to the writer who, in so far as he was able, applied them to the operations of the various plants. Belting was standardized, and repairs analyzed. In one plant alone the cost of repair parts in one department was cut over $1,200 a year—33 per cent. The cost of oil in one factory was reduced nearly $1,500 a year, or 50 per cent. Wherever applied, the principles effected a great saving—but that is another story. The point is that it was proved that the Superintendent—Staff, Assistant Superintendent—Line organization was adapted to carrying out the principles of scientific management in the factory of moderate size.

Meeting the Conditions

These principles are overwhelming in their logic. It is the machinery of the thing that terrifies the owner of the small factory. The Industrial Engineer does not get very far with his "Staff paralleling the Line," "Keeping costs on the operations of each man," "Planning and Dispatching Departments, etc." before his explanations are drowned by cries of "red tape," "too much overhead," "too much system," "our business wouldn't stand it," and the factory is denied the privileges which it is admitted the large plant can afford.

On the other hand, the plan of freeing the superintendent from routine —making him work his brains and, therefore, not wasting any of his high salary in semi-physical labor which a cheaper man can do as well —seems logical and contains nothing revolutionary. The plan is one which appeals also to the superintendent. He still has his authority over his men in case he wishes to exercise it. His prestige is in no way diminished. To maintain discipline and to avoid inroads upon his time he must give orders only through the assist-

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ant superintendent; but the good executive will regard this as no curtailment of authority.

If the business is so small that the superintendent, by calling on one or two of the regular departments for assistance from time to time, can keep the principles of scientific management in operation, the benefit is secured. After the Industrial Engineer has made the analytical time studies and shown him how to continue them on the more simple operations, he can keep this part of the system up and revise the written instruction cards from time to time with occasional help from the engineer. The bonus system once established, the superintendent can make such slight adjustments as are necessary. Dispatching, perhaps, takes part of a clerk's time, some of his regular foreman's time, and demands occasional attention from the assistant superintendent. Routing, once established by the engineer, needs little attention. The same foremen become rather more specialists, and, with little increase in expense, functional foremanship is established. The repair man who is required to keep certain records in conjunction with the man who has charge of the storehouse, is told to do a little more thinking, and to let his helper do more of the manual labor; before long, with the engineer's help, standardized repairs are an accomplished fact. All this is very crude and is adapted to only the smallest sort of a factory. The system is flexible, however, so that the plan outlined above may be expanded. An assistant foreman may be created here and there; specialists made of the various repair men, and the activities of staff officials removed a little more from the line until the conventional Staff and Line organization recommended for the large factory is reached.

To be successful the principles of scientific management must be rigidly adhered to no matter how small the factory. The services of the best industrial engineer available should be secured, and exactly what is contemplated must be thoroughly understood by the owner and executives. If this is done there can be no failure. The writer has installed the system in plants employing from a hundred to three hundred and fifty men, and in every case costs have been reduced, output increased, and quality improved—and there have been no strikes.

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MANAGEMENT OF CENTRAL STATIONS

By Walter N. Polakov

I. PROLEGOMENA

Mr. Polakov, in this first of two papers on the subject, considers, as introductory to the organization of a power plant, the proper selection of location, construction, equipment, and personnel. The second considers the principles of operation. Both papers were delivered as lectures before the graduating class of Sheffield Scientific School of Yale University in the spring of this year.—THE EDITORS.

UNLIKE any other commodity, electricity offers a most interesting example in the matter of price. While cost of living has been steadily increasing until now the cost of mere existence, in accordance with figures compiled by the Bureau of Agriculture, for an average American family is $900, whereas the income of ninety per cent of these families does not exceed $700, the cost of electricity and its selling price is steadily decreasing. This phenomenon of our economic life forcibly arrests our attention and stimulates us to make an analysis of causes.

The fact cannot be ascribed to the sacrifice of profits by the electric companies; although in some instances the management voluntarily limits the rate of profit, even if this means selling a kilowatt hour for three cents. It can still less be explained by the desire on the part of Public Service Commissioners to ruin the electric companies; although there are instances where the large companies were ordered to reduce their selling prices twenty per cent.

Whether this reduction of the price of electricity is made voluntarily or is forced, it is based on one fact: The cost of production has been gradually and steadily decreasing, at least during the last decade or two.

What brought this reduction about?

Broadly speaking production cost consists of two main parts:

a—*Fixed Charges*, which are an aggregate of interest on investment, depreciation of equipment, charge for obsolescence, insurance, rights of way, water rights, and other permanent obligations to be met.

b—*Operating Expenses*, which are usually subdivided into:

1—expenses incurred in connection with generation of power, its transformation and distribution;

2—securing and serving customers, and,

3—expenses incurred in connection with upkeep and maintenance of the property and equipment.

These parts of the production cost with the average progressive electric companies were brought to their present status chiefly, if not exclusively, by the efforts of designers and builders of the central station equipment. Direct current with its limited sphere of distribution was displaced by high voltage — alternating current — this brought about centralization of power plants with corresponding economies and comparatively insignificant transmission losses. Centralization stimulated the development of large size turbo-alternators of high thermal efficiency; and, through serving large territories with a variety of customers, the load factor was improved by

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securing off-peak loads. Again, large consumption of steam and fuel warranted adoption and perfection of automatic stoking and combustion controlling instruments, with efficiency unheard of even a few years ago. In turn automatizing, centralization, and large units greatly reduced the ratio of pay roll to total operating expenses and permitted the employment of a few high priced specialists in place of a number of cheap laborers. Not mentioning numerous advances made in equipment employed for transformation, transmission, and utilization of electricity, the above improvements in central station equipment greatly affected costs—centralization reduced fixed charges—high thermal efficiency of equipment cut the cost of fuel (the largest and dominating operating item)—and automatizing worked in two directions: reducing the pay roll, and maintaining more uniform operating economy.

The owners and managers thus harvest what they did not sow, and the financiers quickly appreciated that investments in public utilities are generally secure and desirable. The tendency developed to scrap the obsolete power plants and get higher earnings from more efficient up-to-date central stations.

An engineer engaged in the design and construction of a central station has an enormous task before him up to the time when he actually starts designing and, ultimately, building. The preliminary research work is all-important in its far-reaching influence on final success or failure of the enterprise.

Location

The location of a central station comes logically as the primary subject of a study. Considering a thermal power plant, *the fuel question is to be studied first.* It might be wise to locate the plant out of the center of distribution in the prospective territory, if desirable collieries or oil fields offer advantages in certain sites over slight disadvantages of a few miles of right of way or transmission line construction, maintenance, and losses. Characteristics of available fuel further determines type of boilers, furnaces, coal handling equipment, ash disposal methods, etc. Price of available fuel is always the chief determining factor in selecting the entire equipment, as expensive fuel may warrant such costly refinements intended for the reduction of losses as electrically-driven auxiliaries, economizers, cooling ponds, etc., which, with low priced coal, will more than offset by their fixed charges the slight reduction in coal rate per kilowatt hour.

Probable future development of the territory served, competition or chances for consolidation, or legal requirements are quite frequently more important factors than the first mentioned.

Water supply, due to its importance, follows fuel closely in consideration. Water for boiler feed, for condensation, cooling, drinking, fire protection, etc., may be had either from natural sources at very slight cost or may be purchased. In many instances quality of water and its price offers a more complicated problem in which three or more variables may come into the equation to be solved.

When these two physical conditions characterizing the advantages of power plant location are studied, the site thus selected shall be again criticized from the view point of available *labor market.* Little or no attention is commonly paid to this complicated question. Away from industrial centers, both skilled and common labor is not readily obtainable, and living conditions for men are

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often unattractive. Economic disadvantages of having frequent changes in personnel may require either building a colony for the employees at considerable investment or keeping on pay roll extra men, most of the time not needed but extremely valuable in case of sickness or sudden resignation of any skilled employee. On the the other hand, schools, shopping facilities, prevailing prices of produce, and cost of living shall be carefully considered as having great influence on wages as well as on stability of the men. Furthermore, social environment in many cases complicates the labor situation, occasionally making otherwise attractive employment objectionable, or vice versa.

Operating methods are in turn materially influenced by the location and local conditions: character of available fuel, nature of prevalent load, equipment selected and arranged accordingly, requires different methods of operation, different numbers of attendants, different standards. Local conditions further determine number of hours of work and consequently number of shifts and operating cost.

The above mentioned factors in their interplay do influence and are influenced by means of transportation, both freight and passenger. Supply of fuel being of vital importance, the means of shipping shall receive full attention. If considerable fuel storage is not practicable, at least two routes for deliveries shall be available the year round; for instance, rail and water fuel routes, or two railways. If the employees can not live in close proximity of the plant, well arranged train or trolley service and cheap fare add as much to the security of service as cheap freight rate and good shipping facilities in respect of fuel and supplies.

Location of the central station both determines and is determined by the possible solutions of the problem of transmission and distribution of current. In a majority of cases in the past, so much attention has been paid to location of the plant in the center of gravity of the distributing system that, in this attempt to save as much as possible of line losses, losses tenfold greater were incurably inflicted through the sacrifice of some of the above mentioned factors.

Whereas some peculiar local conditions are subject to speculation as to their relative value, the influence of the most important ones can be always figured out in dollars and cents. In this manner advantages and disadvantages of several prospective sites for the plant could be balanced up as assets on one side and liabilities on the other. Capitalizing both, one gains a clear conception of relative values of various locations. This, finally, shall be tested again from the view point of probable direction and rate of growth anticipated in the future.

Construction

Passing now to the methods of actual building of a central station on a selected site we must consider four factors:

1. Plans of building and arrangement of machinery shall be in accordance with the requirements of hygiene and safety. Men actually live in their places of work, and too much attention cannot be paid to hygienic requirements. Petty annoyances caused by lack of comfort distract attention from proper performance of work by occupying men's minds with schemes of avoiding inconvenience. Such elementary requirements as good, cool drinking water, comfortable baths, lavatories, dressing rooms, plentiful illumination free of glare and flickering, absence of cold drafts, good ventilation, restful seats, etc., are far more important for se-

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curing operating economies than refinements in design and thermal efficiency of equipment. Tired, annoyed men, with distracted attention will overlook or even cause greater losses than the difference between the best and the next best efficiency of equipment. Firemen invariably increase their efficiency from four to five per cent under improved hygienic conditions. To get the same economy through improved stokers would cost in a 6,000-horsepower plant at least $20,000 against a maximum of $1,200 for comfortable chairs, showers, drinking fountains, and fans.

The importance of protecting machinery to prevent injuries and locating same in safe, convenient, well lighted places, is so self-evident that we may well pass to next requirement.

2. It is becoming more and more common to purchase equipment on performance specification. Turbines consuming one pound less steam per kilowatt hour, or automatic stokers developing an extra five per cent of efficiency, are generally sold at a price so much higher that the additional interest on investment and depreciation almost absorbs the operating economy. This, of course, is only in considering units of the same size and for the same service. In this connection it should not be forgotten that the guaranteed efficiency is not retained by the equipment throughout its life. Water rate of a turbine, for instance, usually increases very rapidly as blades are becoming worn out. Again, and this is the main point to consider, the high operating economy shown on the acceptance test is seldom maintained throughout the years of service on account of lack of sufficient stimulus for the attendants to watch and control the conditions governing the economy to the same degree that testing engineers do on the short trials. It is, however, invariably attained and permanently maintained in the plants where the work is done on task with bonus.

3. This brings us to a point when we shall consider the *influence of first cost of equipment on the operating cost.*

Total amount of money invested in the plant and transforming transmission equipment cannot be depreciated at a fixed rate. Basing depreciation rate on the useful life of equipment it is quite evident that the life of a furnace is shorter than that of a crane, or the life of bus bars longer than the life of turbine vanes. From this viewpoint alone the selection of equipment for economical operation is an intricate procedure, it being self understood that the parts of natural short life shall be selected at the lowest possible cost, whereas, if long service is assured, comparatively high prices paid are but good investments. Similarly, the design of parts of the unit shall be such that in case of accident the break will affect the part cheapest and quickest to replace, and so far as possible design shall be adopted permitting continuation of service though at small sacrifice of either capacity or economy.

The largest integral part of fixed charges that a power plant bears is the interest on investment. This charge begins from the moment of the beginning of the construction of the plant, and the longer it is under construction the greater will be the accumulated interest before it can be charged as overhead on the product. It is seldom appreciated, however, that the proper manner of handling this problem is to rush the construction period and, laying aside a sufficient reserve to meet the interest during construction, to treat this amount during the operating period as added

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to the actual investment. Other elements of fixed charges as insurance, for instance, may be often greatly reduced by careful layout in compliance with regulations governing the insurance premiums.

4. Obsolescence is comparatively a new consideration and, as we pointed out in the very beginning, is chiefly due to the rapid rate with which the development of highly efficient power generating equipment has lately been progressing. It was perfectly natural, therefore, that several cases should have occurred where the plants at the end of their construction were already obsolete as compared with up-to-the-minute ideas. This fact, however, is far from being alarming, provided, of course, that there were no fundamental errors in the original plans. Suppose, for example, a steam electric central station built a few years ago, develops twelve per cent thermal efficiency from coal pile to bus bars. Comparing same with an up-to-date plant capable of developing thirteen and one-half per cent thermal efficiency it is in some respects "obsolete." Yet, assuming that same labor and maintenance expenses are necessary in both cases, this $\frac{13\frac{1}{2} - 12}{12} = 12.5$ per cent of gain in newer plant will affect only some seventy to seventy-five per cent of total operating expense, that is, the fuel bill only. This reduces its actual advantage to only eight and three-fourths per cent and, as it is most likely that the first cost of the more efficient plant was five per cent higher, costing $1,050,000 instead of $1,000,000, the interest and depreciation on the excess cost at only a ten per cent rate would amount to $5,000 annual extra overhead. With an annual output of 8,000,000 kilowatt-hours at four cents per kilowatt-hour the operating expense would be $32,000 in the old plant and $29,200 in the new. In the final count the operating saving of $2,800 is more than offset by a saving of $5,000 on smaller fixed charges for the older plant.

In a broader sense of the word, obsolescence means unsuitability of equipment for the changed requirements, as is the case with a direct-current plant in a territory that could be more profitably served by alternating current. The practice of sinking fund in addition to the far-sighted consideration prior to construction seems to be the most helpful means to provide against losses due to obsolescence.

Passing now from the physical equipment and layout of a plant and its effect on the cost of product and profit of the enterprise to the more important details, we must apologize for a heresy of classifying the personnel and records as equipment. From the standpoint of a designer, men are not parts of a plant; from the standpoint of an engineer and manager, they are but integral parts of a plant. A plant, not equipped with men, recording devices, and stores, is but a curiosity shop or exhibition, not an operating unit.

Personnel is, in fact, the all-important element of plant equipment.

Selection of employees shall rightly require more study than selection of boilers and generators. Unfortunately the art and science of hiring is so young and the basic principles yet so vague that the great majority of companies operating plants still continue to waste enormous amounts of money and dissipate natural resources in addition to doing a great social injustice in this respect. Time honored habits of "hiring and firing," building up an organization by "hit and miss" method, has generally two immmediate results: Men, hired because they did not want to starve,

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perform their tasks indifferently, merely avoiding gross neglect, and, therefore, the actual efficiency of the plant is short of the inherent efficiency of equipment; and frequent changes of employees, either because of their low efficiency or because of a fancy to advance a good fireman to a position of bad engineer, result in lack of thoroughness, lack of pride in their profession, and in extra expense in training unfitted men.

WAGES

It is not natural, as some writers assert, for men to sell their time. They offer something for *guaranteed income.* Since time rate eliminates variance of rate and assures more uniform income, it is generally preferred. In itself, however, the valuation of a man's service does not differ from that of any other commodity. As in the case of an engine the cost of production of human energy can be analyzed as follows:

1. *Operating expense*—Cost of living of the employee himself.

2. *Maintenance*—In a broader sense is maintenance of the working class, *i.e.*, reproduction and bringing up children.

3. *Fixed Charges*—Expenses necessary to cover man's duties as citizen, as member of society, and interest on investment represented in education, experience, etc. We might well consider here also the parallel between the obsolescence and insurance against sickness, old age, etc.

Finally, as selling price differs from the cost of production by the usual rate of profit, the total of the above three elements of wages differs from man's earning by the margin granted for extra comfort, etc., which vary with local conditions, national standards, recognized habits, etc. In other words, *the common rate of wages paid does not represent the value of man's service or work but merely his market price.* An average power plant employee working for 25 cents per hour may be capitalized at five per cent for $18,000.

It is logical in case of capitalization of a workingman, or determining his wages, to apply the generally adopted method of valuation in accordance with earning power. If we are willing to pay to the manufacturer of a turbine a premium on steam economy, the bonus paid to the workmen for living up to certain standards of performance set for him may also be considered a premium. It not only insures greater operating economy, but increases paying investment at the same time; as an employee well trained, satisfied and interested in his work, is the greatest asset for the industry.

There is hardly any other brand of industry where the fact that high wages means cheap product is more pronounced than in power generation. While pay roll of a central station usually does not exceed fifteen per cent of total operating expense, five per cent saving produced by men is equivalent to twenty-eight per cent increased pay roll; and, as it is commonly possible by means of training of employees to accomplish twenty-five per cent saving if bonus is offered, it is safe to say that it means an increase of 240 per cent in the value of the labor.

Having duly considered the above prolegomena to the organization of a power plant, selecting its location, equipment, and personnel, it would be preposterous to assume that the plant is now ready for operation.

Inasmuch as generation of the power shall be made at the cost consistent with the investment and the income, it should be equipped with a mechanism that accomplishes for the financier and the manager a double duty: it should record the perform-

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ance as it was, and it should, furthermore, show how near the actual performance approximates possible perfection.

To fulfil these expectations the mechanism shall not only correctly and fully record all conditions and result of operation, but shall automatically and instantaneously allocate any possible loss incurred. The determination of the magnitude of this loss and means of its elimination constitutes a new problem—of methods, not of equipment.

To be continued

DISTRIBUTING OVERHEAD EXPENSE

By Nicholas Thiel Ficker

V. RENT EXPENSE AND A STANDARIZED METHOD OF DISTRIBUTING IT.

In previous chapters of this series, which treats only of that portion of overhead included in manufacturing accounts, Mr. Ficker has discussed: June, the general errors in applying manufacturing expense to costs of production; July, the two main divisions —machine expense and material expense; August, the classification and interpretation of general ledger accounts, and, September, the segregation and distribution of power expense. The present chapter takes up the proportionment and distribution of rent expense. Next month he will show how fixed charges—depreciation, insurance, and taxes—should be distributed, and will follow that with a final chapter describing the machine unit system.—THE EDITORS.

IN the preceding chapter a detailed analysis was made of administration and power expense charges as divisions of manufacturing expense. We found that administration expense, for example, is distributable to production centers on a basis of the number of employees in each center; we likewise found that power expense is distributable on the basis of units of power. In other words, our analysis has shown thus far that each division of manufacturing expense is distributable according to different methods of procedure. Rent expense, which we are about to analyze, is proportioned on the basis of floor space occupied; the unit of distribution is, therefore, the square foot and the method to be followed in arriving at this charge per unit is herewith outlined.

Rent expense may be arbitrarily divided into two parts: (a) Fixed Charges pertaining to Grounds, Buildings, and "Rent Permanent Fixtures" (permanent fixtures pertaining to buildings), and (b) Annual Maintenance. Under (a) should be included:

1. Depreciation on all buildings.
2. Depreciation on rent permanent fixtures (this includes such permanent fixtures as are common to the whole building and which were specified in the preceding chapter under (Permanent Fixtures pertaining to Buildings).
3. Insurance on all buildings and on "rent permanent fixtures."
4. Taxes on grounds (except such grounds as are considered as surplus, *i.e.*, purchased in advance of present requirements).

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Taxes on buildings.
Taxes on "rent permanent fixtures."

5. Interest on investment (consisting of interest computed at a reasonable rate on net value—the face values of grounds, exclusive of surplus—on buildings and on "rent permanent fixtures," less all depreciation on plant written off to date. Mortgages or bonds outstanding against the property should not be deducted).

Under (b), Annual Maintenance, such items of expense as the following would be included:

1. Salaries of janitors, sweepers, cleaners, watchmen, passenger elevator operators, fire brigade, etc.
2. Lighting (depreciation of lighting plant, or proportion of power consumed in lighting).
3. Fuel for heating.
4. Repairs to buildings.
5. Repairs to "rent permanent fixtures."
6. Changes to buildings and "rent permanent fixtures."
7. Written off buildings and "rent permanent fixtures."
8. House service supplies, such as soap, towels, toilet, and janitor supplies.

A summary of rent expense made according to these two divisions and applied separately against the total number of feet of effective floor space will give a rate per square foot for both fixed charges and maintenance. Comparisons can then be made between the expenses of different periods and any abnormal variations easily located.

In order to arrive at the total effective floor space, the following items should be taken into consideration: All space in buildings which might be used for factory, warehouse, or office purposes, including aisles, engine and boiler rooms, toilet rooms, stairways and elevator shafts (excluding light shafts), pillars, and walls; all open yards used in the carrying on of the manufactory's business, including such space as might be used for the storage of raw material, scrap, etc., also any roofs used for such purposes; and all driveways, courts, and railroad tracks owned by the company and used for shipping or receiving merchandise.

In cases where buildings are rented the total annual rent charge to expense should include (a) annual rent paid; and (b) annual maintenance, which is not included in rent paid.

When figuring depreciation, insurance, and taxes, *net* values of plant should be used as a basis for making calculations. This means that from the face values of buildings, and "rent permanent fixtures," as shown on the respective ledger accounts, deductions must be made for all depreciation which has previously been written off together with the accrued depreciation up to the end of the current year. No deductions, however, should be made for "mortgages" or "bonds payable." All rates used should first have the approval of the management as they directly effect the manufacturing expense charge which we are interested in distributing to costs of production.

In classifying direct expense charges to "rent" during the year, the same procedure should be followed as explained in chapters three and four.

In chapter three, we designated the shop expense (manufacturing expense) account as account No. 11. For sub-classification purposes let us assume that all numbers from 100 to 199 inclusive were assigned to administration expense; all from 200 to 299 were assigned to power expense, and all from 300 to 399 to rent expense. A reference list of these classifica-

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tions pertaining to "rent expense" for the year would be made up as follows:

RENT EXPENSE
CLASSIFICATION REFERENCE LIST

301—Changes to buildings and rent permanent fixtures
302—Depreciation on buildings and rent permanent fixtures
303—Drawings and surveys
304—Inspection and supervision of maintenance of buildings and fixtures
305—Interest on investment in grounds, buildings and rent permanent fixtures
306—Renting other buildings
307—Repairs to buildings and street paving
308—Repairs to rent permanent fixtures
309—Repairs and inspection of passenger elevators
310—Supplies for cleaning
311—Supplies for fire protection (Not including apparatus)
312—Supplies for watchmen (oil, lanterns, etc.)
313—Stationery
314—Salaries, attendants to heating system, fire brigade, etc.
315—Salaries, passenger elevator operators
316—Salaries, pumping station (fire and house service)
317—Salaries, sweepers
318—Salaries, ushers and watchmen
319—Taxes on grounds, buildings, and rent permanent fixtures
320—Watch box service
321—Water (other than manufacturing)
322—Unclassified rent expense
323—Service charges for light (Brought forward from power expense and from gas expense)
324—Service charges (Brought forward from administration expense)
325—Transfers to other accounts (credits)

The "shop expense account" has been referred to as Account No. 11 in these papers, and as rent expense is simply one of the divisions of shop expense, then, by using the reference list of sub-classifications made up for each division of expense, we would classify charges pertaining to any kind of expense according to the classification numbers assigned thereto. For example "Renting of other Buildings" would be classified 11-306, by which (11) would denote the account number and (306) being in the three hundreds would designate the charge immediately as a rent expense item, the details as to kind of expense being obtainable by reference to the classification list.

STATEMENT OF ANNUAL RENTAL EXPENSE AND COST OF EFFECTIVE FLOOR SPACE FOR THE YEAR 1915

FIXED CHARGES:		
Depreciation on Buildings and Rent Permanent Fixtures	$5,686.96	
Insurance " " " " " "	27.10	
Taxes " " " " " "	104.86	
Interest on Investment in Grounds, Buildings, and Rent Permanent Fixtures (Figured @ 5% of Net Values)	7,279.33	
Rental of (2) Buildings from A. B. C. Realty Co	25,000.00	
Total Fixed Charges		38,098.25
MAINTENANCE:		
Repairs and Changes to Buildings	4,419.74	
Repairs and Changes to Rent Permanent Fixtures	110.83	
Salaries Watchmen and Doorkeepers	2,103.05	
" Sweepers and Cleaners	3,852.50	
" Yardmen	780.00	
Water (House Service)	1,872.17	
Fire Protection Expense	493.50	
Supplies for Cleaning	169.25	
Gas Purchased	1,031.84	
Electric Illuminating Expense — Power Purchased	115.92	
Electric Illuminating Expense — Power Generated	966.53	
Electric Illuminating Expense — Supplies	267.47	
Drinking Water Expense	82.47	
Total Maintenance		$16,264.95
Total Annual Rent Cost		$54,363.20

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To the direct charges to rent expense as made during the course of the year, transfer must now be made for "service charges" from other divisions of expense. For example, a transfer must be made from that division of manufacturing expense known as "fixed charges" for the proportion of depreciation, insurance, and taxes chargeable to "buildings" and to "rent permanent fixtures," and for taxes on "grounds," as these form part of the rent expense. Transfers must also be made in like manner from "power expense" to "rent expense" for electric illumination, etc. By adding these service charges to the direct charges, the total expense chargeable against "rent" can be arrived at. The classifications for use in making the transfer entries in the subsidiary expense ledger are included with those listed above.

As we are interested in determining a rent rate per square foot for both fixed charges and maintenance as included under rent expense, let us analyze the annual rent charge of $54,363.20, stipulated in chapter four, according to these lines of distinction. This analysis would then appear as shown at the foot of the page opposite.

A summary of floor space against which the above expense is applicable would then be made and shown in the following manner:—

Manufacturing space	29,742 sq. ft.
Material "	26,666 " "
Office "	4,723 " "
Space used for other than Material or Manufacturing	6,063 " "
Total Occupied Space	67,194 sq. ft.
Unoccupied Space	38,719 " "
Grand Total Floor Space	105,913 sq. ft.

RESUMÉ

Number of square feet effective floor space	105,913
Fixed charges per square foot	$0.3597
Maintenance per square foot	0.1536
Total rental cost per square foot	$0.5133

Having established a rent expense rate of $0.5133 per square foot, transfers can now be made to power expense on the basis of floor space occupied by the engine and boiler rooms; to material expense for space used by storerooms; and to machine and tool expense for space used for manufacturing purposes, etc., the charge in each case being determined by multiplying the number of feet of floor space occupied by the rate of $0.5133. These transfers would then be shown as follows:

Total Annual Rent Cost		$54,363.20
Transfers to Other Accounts:		
Power Expense	$2,716.13	
Material Expense	11,213.55	
Tool Expense	15,119.46	
Administration and Clerical Expense	2,424.32	
Shipping Expense	$2,474.11	
Engineering and Draughting	504.20	
Total Transfers		$34,451.77
Balance		$19,911.43

The balance indicated is equivalent to the charge against 38,791 square feet of unoccupied floor space.

By using a method similar to the one here outlined for determining a rate per square foot of floor space for both fixed charges and maintenance, a basis of comparison can be established between the rent expense of different periods and as a basis for arriving at decisions as to the purchase, rental, or construction of new buildings. It is also a means of showing very clearly the actual expense involved through carrying surplus space. An analysis of this kind has been known by the writer to have resulted in an entire rearrangement of production centers and storage space so that the excess floor space could be rented and an income of no mean proportions derived therefrom.

The method herein outlined for analyzing the annual rent charge is of course subject to modifications to meet existing conditions at the plant

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where it is to be applied. In some instances a much more elaborate system of classification and a more detailed analysis may be necessary. For example, where "Water for House Service" has simply been given one sub-classification, (321) in the reference list of classifications, in extensive manufacturing establishments, similar to the large steel mills, railroad repair shops, or brass mills, the charge for water expense chargeable to rent alone might necessarily have to be divided into five distinct classes, as: *a*, Fire protection, hydrants and sprinklers; *b*, grounds service; *c*, house service for toilets; *d*, drinking water; *e*, high-pressure service for power for elevators. These would use classification numbers from 330 to 349 inclusive. Where divisions of this kind are necessary the expense is distributed to the respective systems on the basis of cubic feet of water used as indicated by the meter readings, and where this is not possible the distribution is made on the basis of estimated consumption.

As mentioned in the preceding chapter on power expense distribution, light or illuminating expense is chargeable to rent. This introduces another factor which is applicable at certain plants, that of generating gas. Where this is done, the classification of expense pertaining thereto should be made in a manner similar to that shown below:—

GAS GENERATING EXPENSE

350—Accidents
351—Belting on machine
352—Changes to gas plant
353—Depreciation on generating, purification, and distributing equipment, and buildings
354—Generator fuel (coke, coal, etc.)
355—Enrichers (oil, etc.)
356—Purification materials (iron oxide, shavings, etc.)
357—Rags, oils, cleaning supplies, waste, etc.
358—Repairs to buildings and fixtures
359— " " machinery and tools
360—Insurance
361—Taxes
362—Wages of gas maker and assistants
363— " " clinker and ashmen
364—Inspection expense
365—Service charges (brought forward)
366—Transfers to rent (class. No. 323) and other accounts (credits)

It will be noted that the classification numbers assigned to the above reference list are in the 300 class. This has been done because of the fact that practically all of this expense is finally closed out into rent expense of which it really forms a part, because the gas generated is used for illumination purposes. Any gas distributed for direct manufacturing uses, such as gas ovens, heaters, blow pipes, etc., would be chargeable to "machine and tool expense," through the transfer classification No. 366.

Still another possible division of expense chargeable to rent is that of the care and upkeep of grounds. This has become a factor of considerable importance of late years because manufacturers are appreciating the importance of desirable and attractive surroundings to the works proper as an inducement to labor and to sanitary conditions throughout all departments. It is a proven fact that where large, well-ventilated rooms with abundance of light are provided, increased efficiency has resulted therefrom. In the same way, if the outlook from the interior of the factory is over spacious, well-kept, green lawns spotted here and there with shrubbery, the expense involved will be repaid many fold through different sources. Many of the larger plants, especially, have laid out tennis courts, baseball diamonds, and running tracks on the grounds adjacent to or surrounding the factory buildings, all for the use of their employees. The results attained in the way of competition between different departments and with other organizations has resulted in immeasurable benefits, and the scheme is now being applied wherever conditions and locations permit.

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However, all this involves extra expense and this expense like all other kinds of expense must be controlled in order to derive the maximum return on the expenditure involved. The care and upkeep of grounds is chargeable to rent expense and as these expenses must necessarily be classified, a reference list of classifications should be made up in the following manner:—

RENT EXPENSE "GROUNDS"

375—Changes to fences, driveways, walls, gates, houses, etc.
376—Depreciation on houses used as part of the grounds
377—Depreciation on fixtures, etc.
378—Insurance on houses, equipment, etc.
379—Repairs
380—Salaries, superintendent of grounds and watchmen
381—Salaries, care and upkeep of grounds
382—Taxes
383—Service charges—water (transferred from water expense)
384—Service charges—administration (transferred from administration expense)
385—Transfers to rent (closed out into classification No. 321)

A method of expense segregation along the lines here indicated makes possible a control over each sub-division of rent expense not possible where the charges are all grouped under one general heading. For small factories such an elaborate system of classification is not warranted, but where manufacturing is done on an extensive scale even a more detailed analysis may be necessary. The object here has been to show the possible ramifications of rent expense in its broader applications.

Referring back to the original summary of rent expense at the beginning of this chapter, we found that this amounted to $54,363.20 for 105,913 square feet of floor space, with an equivalent rate of $0.5133 per square foot. This space must now be classified so that an amount proportionate to the floor space occupied can be charged to each division of manufacturing expense, such as administration, power, machine expense, etc., and in this way be eventually closed out into either machine or material expense. A classification of floor space by expense classification follows:—

Items chargeable to Machine and Tool Expense:

Includes space in manufacturing departments occupied by machines and benches, and the surrounding space, including private aisles necessary for their proper operation and maintenance. This space should be accounted for as a balance after all other areas have been deducted from the total area of each department. It should be finally distributed amongst the various benches and machines for use in determining a machine rate of expense loading, as will be explained in detail further on in the chapter on the Machine Unit System. Includes, also, tool rooms.

Items chargeable to Administration Expense:

General and clerical offices (all offices included under shop administration expense); manufacturing offices of general foreman, foreman and shop clerks; space occupied by lockers.

Items chargeable to Material Expense:

Offices pertaining to material; stock rooms, including private aisles; raw and process stock space, outside of stock rooms; tracks and space occupied by scales (pertaining to material); freight elevator space; three-fourths of main aisles in the manufacturing and stock departments; receiving rooms; inspection laboratories.

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Items chargeable to Power Expense:

Steam generating system, including space occupied by boiler room, coal bunkers, ash bins, ash conveyors, etc.; electric generating system, space occupied by generators, switchboards, etc.; electric distributing system, space occupied by mains, etc.; transmission system, space occupied by motors, shafting, switchboard, etc., other than transmission stock; compressed air system, space occupied by compressors and piping.

Items chargeable to Light Expense:

All space taken up by lighting systems.

Items chargeable to Rent Expense:

Stairways and passenger elevators; one-fourth of main aisles in the manufacturing and stock departments and all of the office corridors; sinks and toilet rooms; vacant space in shop not in use.

This classification of floor space forms the basis for prorating and distributing rent expense to the several other divisions of manufacturing expense heretofore mentioned. These areas should be checked up at periodic intervals, as extensive changes or removals will effect costs of production either through excessive or insufficient charges. Office space should be charged a somewhat higher rate per square foot than regular space. This can be determined by an analysis of expenses and will be found to average closely to a ratio of two to three; that is, if regular space costs fifty cents per square foot, office space would be found to average close to seventy-five cents; the higher cost is due to more effort being expended in the cleaning and maintenance of the office space.

The purpose which the writer has had in making the foregoing analysis of the annual rent charge has been to show the relative importance and the ramifications of one of the most important divisions of manufacturing expense; one in fact which has not been treated seriously enough by both manufacturers and accountants alike, that is, from a cost standpoint. The illustrations used herein are not intended for use either in very small or exceptionally large plants; they must be changed to fit existing conditions at the plant where they are to be used. In trying to strike a happy medium and at the same time show some of the possible ramifications the purpose has been, therefore, to provide a basis of reasoning rather than to establish certain fixed rules or lines of procedure to be followed.

In our analysis of manufacturing expense we have considered, thus far, administration expense, power expense, and rent expense. In the next chapter an analysis will be made of depreciation, insurance, taxes, and interest charges. As these constitute a very important part of the total overhead which we are interested in assessing against costs of production an analysis of certain common errors made in computing these charges will be discussed and a standard method of determining what they are will be outlined.

To be continued.

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THE MECHANICAL HANDLING OF COAL AND ASHES IN THE POWER PLANT

By Clarence Coapes Brinley

In the first part of this paper, last month, Mr. Brinley described the several systems of coal and ash conveyors and discussed the conditions to which each system was best suited; he also gave some data on comparative costs of installation and operation. This second part is devoted entirely to descriptions of several large power plants and their coal and ash handling equipment. Later Mr. Brinley will present a paper on automatic stokers.—THE EDITORS.

IN the first section of this paper, the power plant of the Havana Electric Railway Light & Power Company was described. This showed an inclined belt conveyor used in conjunction with a hoisting tower serving a water side plant. In this section the handling equipment of several plants will be described to show the application of other types of machines.

Figure 21 shows a hoisting tower and cable railway handling the coal supply at the Christian Street station of the Philadelphia Electric Company. This apparatus was installed several years ago. A two-man Mead-Morrison hoisting tower, equipped with a one-ton automatic grab bucket operated by a 14 by 24-inch double-drum, double-cylinder steam hoist and a 10 by 12-inch single-drum trolley engine, is located on the wharf. Coal is elevated to the receiving hopper 70 feet above the dock level, passed through a single-roll crusher, and carried in three-ton self-dumping cars to a hopper outside the boiler house 450 feet from the wharf. The tower and railway trestle are constructed entirely of steel. A 25-horsepower electric motor is used to drive the coal crusher, and a 35-horsepower motor to operate the cable railway. The hoisting equipment is capable of making four round trips per minute; this would give a possible capacity of four tons per minute or 240 tons per hour, but the time consumed in moving the boat and cleaning up reduces the capacity to about 150 tons per hour. The hopper at the boiler house delivers into a gravity-discharge bucket elevator, which in turn delivers to two flight conveyors distributing to the overhead bunkers.

A timber storage pocket, which may be seen in Figure 21, was originally placed beneath the cable-railway trestle and coal was stored in it for delivery by trucks to a station in another part of the city. This station has since been equipped with coal handling apparatus and the pocket has lately been removed.

This plant is now being enlarged to take care of the heavy load involved in handling the electrification of the Pennsylvania R. R. suburban lines entering Philadelphia, now under way. An entirely new boiler house has been built directly back of the one shown in Figure 21. This will call for an increased coal supply, to handle which the original steam hoisting tower has been remodeled and converted into a one-man tower and a new one-man electric tower has been constructed beside it. Figure 22

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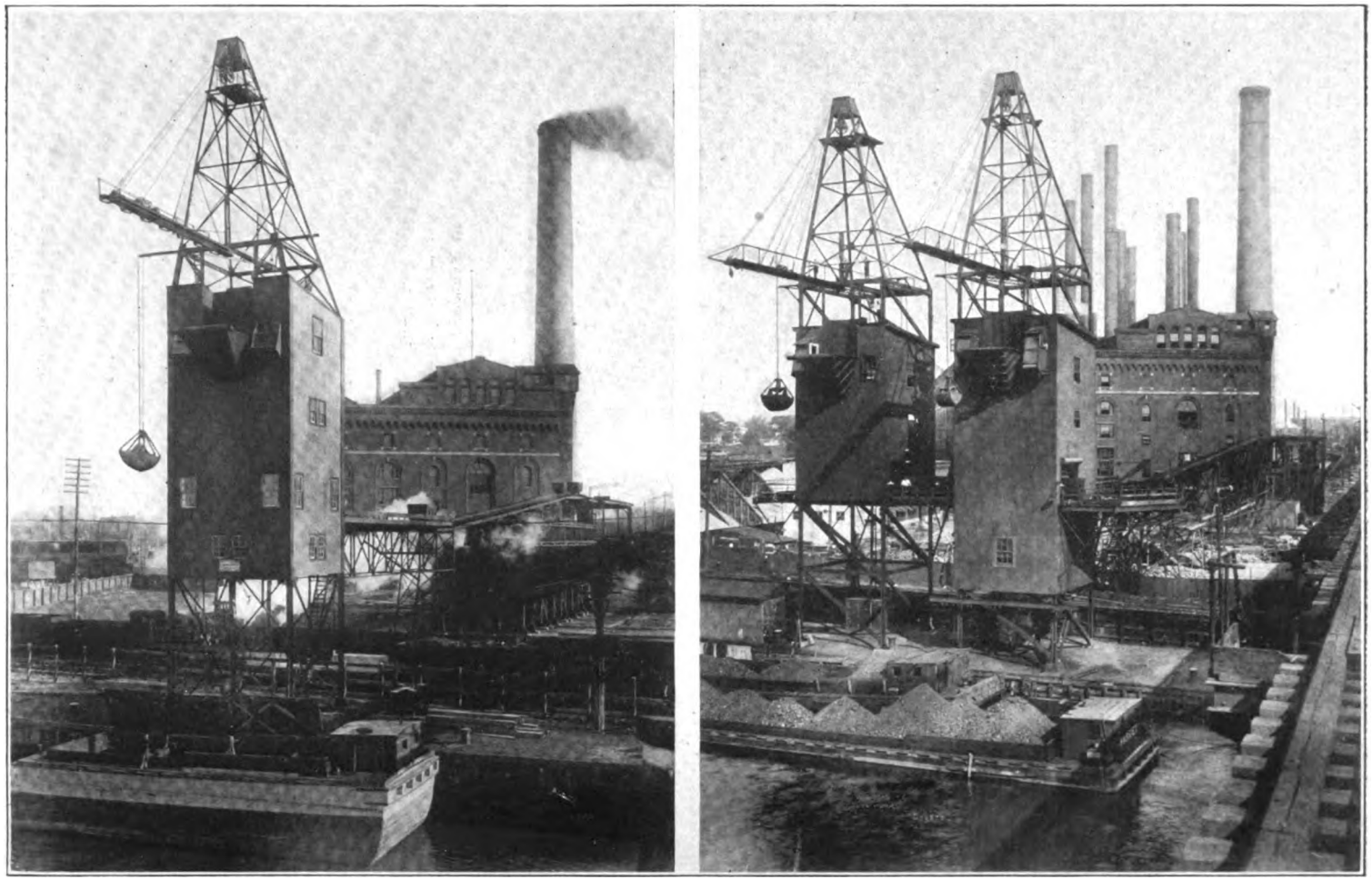

FIGS. 21 AND 22. OLD AND NEW COAL HANDLING EQUIPMENT AT THE CHRISTIAN ST. STATION OF THE PHILADELPHIA ELECTRIC CO.

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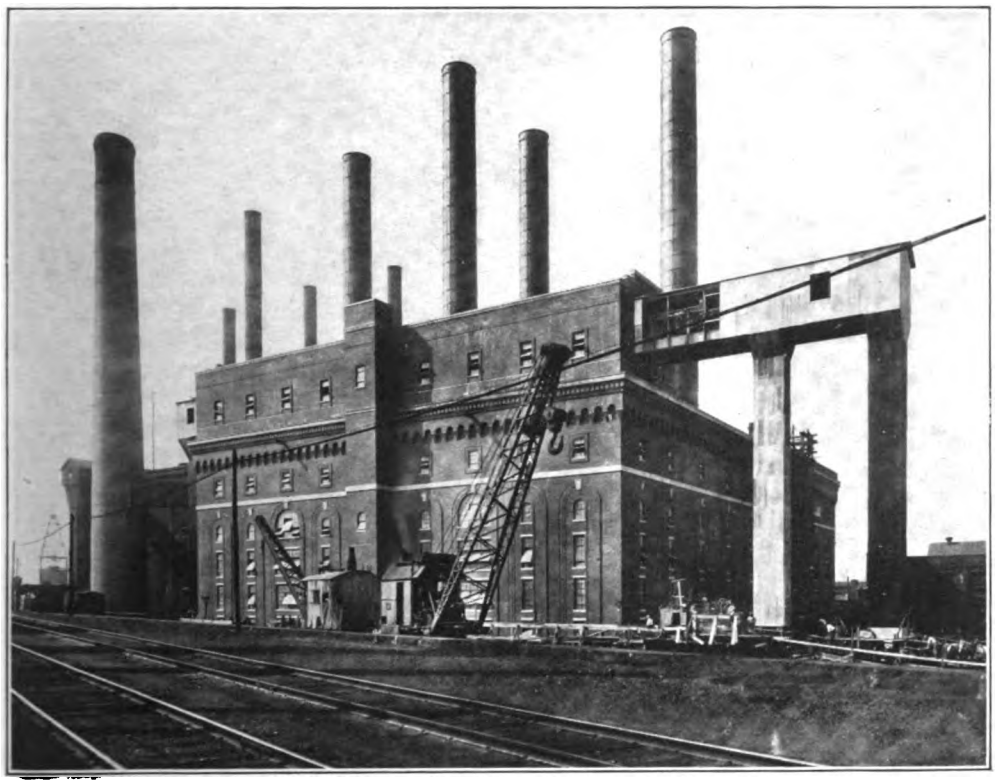

FIG. 23. NEW BOILER HOUSE, CHRISTIAN ST. STATION, PHILADELPHIA ELECTRIC CO.

shows the new arrangement. The cable railway has been re-arranged so that coal may be delivered to the cars from either tower.

The new electric tower has been equipped with a one and one-half-ton grab bucket operated by a double-drum electric hoist and a single-drum trolley. The hoist is driven by a 300-horsepower motor and the trolley by a 35-horsepower motor. All gears are of cast steel with cut teeth and run in oil-tight casings. This equipment is capable of making three round trips per minute, which gives a possible capacity of four and one-half tons per minute, or 270 tons per hour. The new tower is also equipped with a single roll crusher.

The cable railway will eventually be extended 260 feet to the new boiler house, and sufficient cars added to handle the combined tonnage of the towers; but the equipment in the new boiler house has been arranged to receive coal by rail as well. Two McCaslin overlapping bucket carriers have been installed, as shown in Figure 23, one on either side of the building. These machines take coal from a hopper under the railroad tracks, after it has passed through a crusher, elevate it, convey it across the end of the building, and deliver to flight conveyors which distribute to the bunkers. The vertical lift is 110 feet, and the horizontal haul about 200 feet for each conveyor. The boilers are arranged in four rows, and two overhead bunkers run the full length of the building, each serving two rows of boilers. Two mono-bar flight conveyors are used to distribute to each bunker, and the McCaslin conveyors

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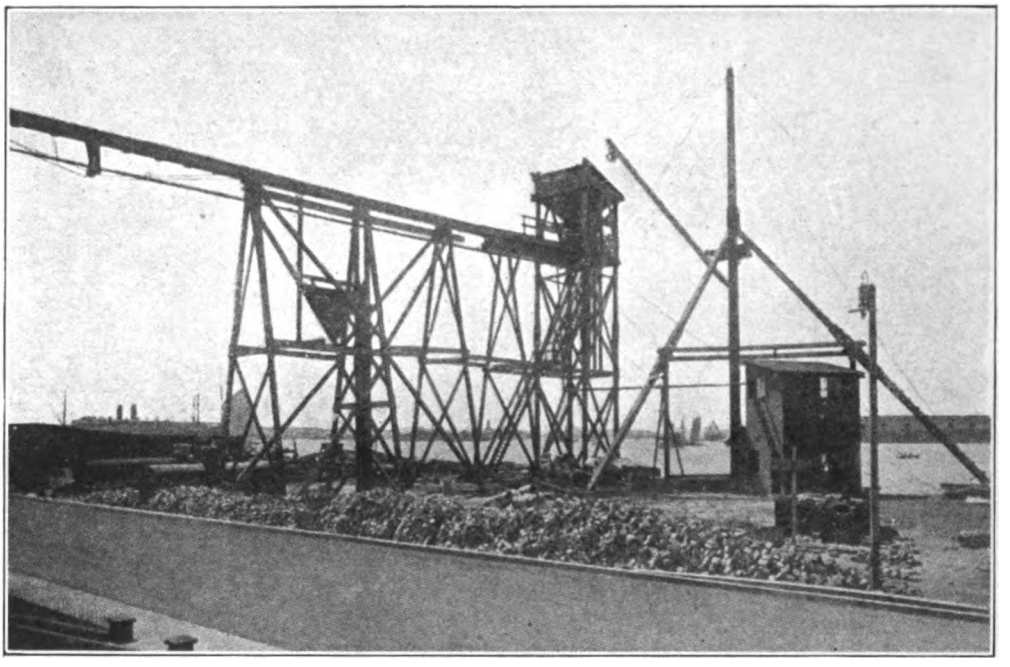

FIG. 24. CASA BLANCA PUMPING STATION, HAVANA
A mast and gaff rig with an automatic railway carry coal from barges at the water front to the boiler plant shown on the opposite page.

are overlapped a sufficient distance to enable each to serve both pairs of flight conveyors. The McCaslin conveyors are equipped with 34 by 36-inch overlapping buckets, and, traveling at the rate of forty feet per minute, have a capacity of 160 tons per hour. Each conveyor is driven by a 40-horsepower motor, but the actual power consumption is calculated to be somewhat less than this. The hoisting tower and the McCashin conveyors were installed by the Mead-Morrison Manufacturing Company; the flight conveyors by the Link-Belt Company.

This plant is being equipped with one of the largest suction conveyors thus far installed. Four lines of 10-inch pipe will connect the ash hoppers in the basement beneath the boilers with a 300-ton re-inforced concrete storage tank to be constructed some distance from the building. The conveyor lines will eventually be extended to the old boiler house; and provision is made for an additional 300-ton storage tank. This work is being done by the Guarantee Construction Company, New York.

The following plants have recently been equipped with coal and ashes handling apparatus, and show the application of many types of machinery.

A mast and gaff rig with an automatic railway applied to a plant some distance from the water front is shown in Figures 24 and 25. The pictures were taken from about the same point looking in opposite directions along the run of the automatic railway. This is the Casa Blanca pumping station on the shores of historic Havana harbor, across the inlet from the main city. The boiler house is 160 feet from the water front, and the automatic railway is carried on a trestle 50 feet above the highway which connects old Morro Castle with the inland. In Figure 25 we are looking out over the harbor, with the city of Havana in the background, to the

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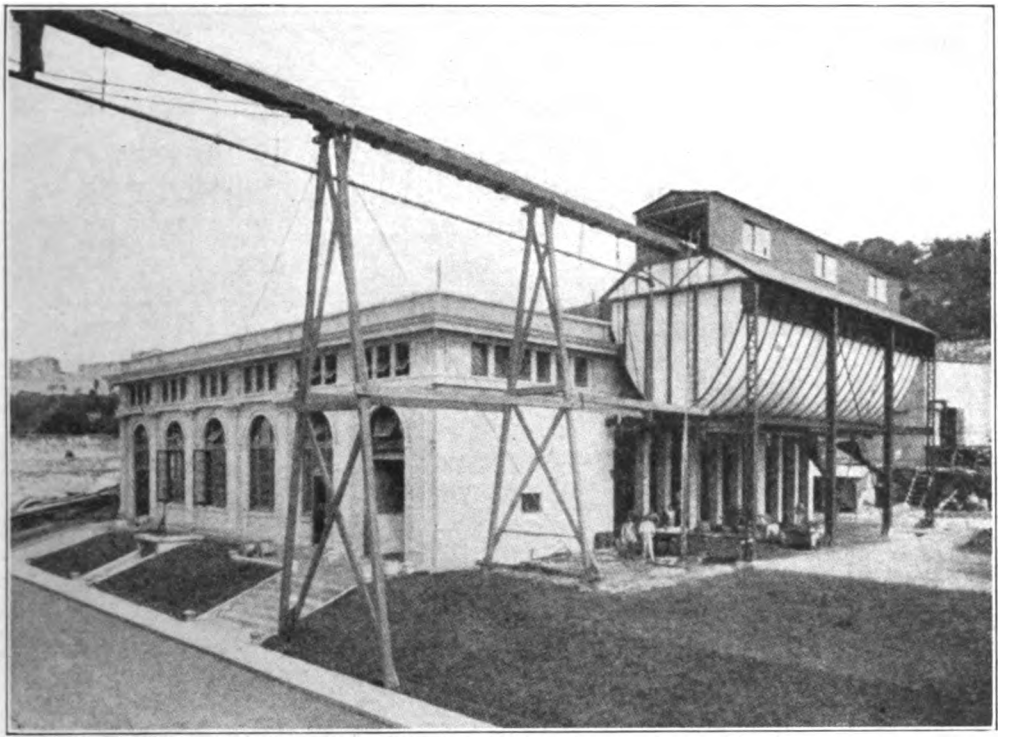

FIG. 25. CASA BLANCA PUMPING STATION, HAVANA
Two quarter-ton traveling hoppers carry coal from the bunker gates and deliver it to stoker magazines inside.

spot where the battleship Maine was destroyed.

Coal is unloaded from barges at the rate of 60 tons per hour and delivered to the hopper over the automatic car by a Mead-Morrison mast and gaff rig equipped with a one and one-fifth-ton automatic grab bucket operated by an 8 by 10-inch double-drum hoisting engine. It is then carried over the trestle to a 425-ton suspension bunker next to the boiler house by a one-ton self-dumping car which is automatically returned to the loading point by the counterweight seen suspended beneath the tracks in Figure 25. Suspended from a single track beneath the bunker, two quarter-ton traveling hoppers take coal from the bunker gates and deliver it to the stoker magazines inside the boiler house. The coal consumption of this plant is not very great, but the supply is received in barges of about 400-ton capacity from the southern ports of the United States; for this reason the bunker was made large enough to hold an entire boat load of coal with a safe margin.

Mechanical handling equipment was not considered in the design of this station, and it was necessary to locate the bunker outside the boiler house, but the result is rather better than the usual for this condition; the lines of the structure are well proportioned and it makes an altogether pleasing impression when seen from the harbor or the city beyond.

The hoisting rig and railway trestle are constructed of timber and supported on concrete piers. The supporting structure of the bunker and the housing above are of steel and the

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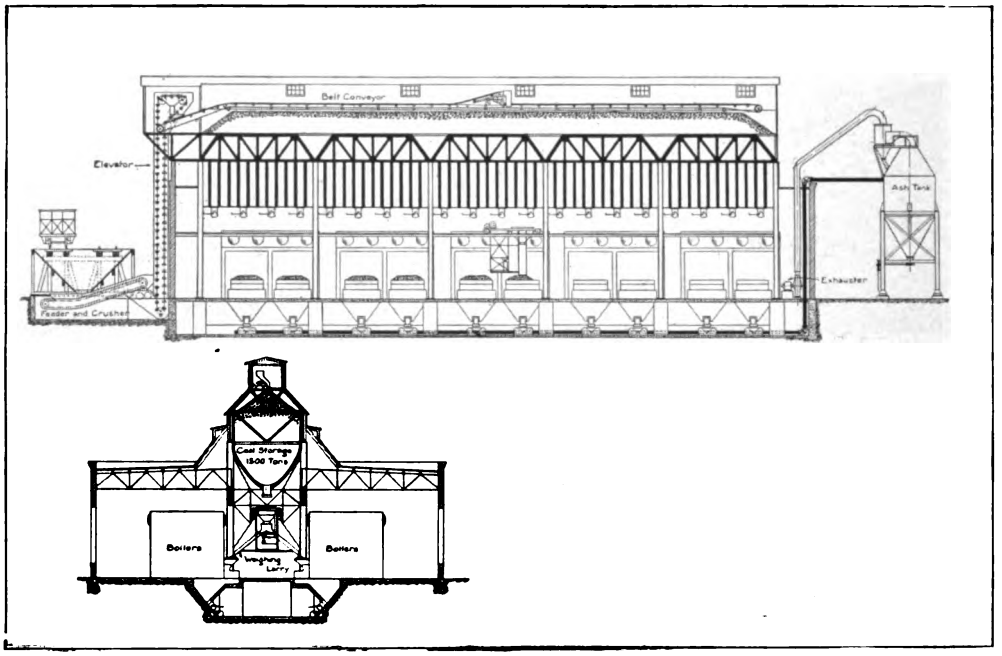

FIG. 26. COAL AND ASH HANDLING SYSTEM FOR RIVERSIDE AND DAN RIVER COTTON MILLS, DANVILLE, VA.

bunker bag is of concrete over ferro-inclave.

The power plant of the Riverside and Dan River Cotton Mills, at Danville, Va., is an example of what may be accomplished in remodeling and equipping an existing boiler house. The cross-sectional view in Figure 26 shows the plant as it is today. Originally the roof trusses were supported on a single row of columns in the center midway between the boiler fronts, and the roof was almost flat. As can be seen in the illustration the center row of columns was removed, the roof trusses shortened and attached to two new rows of columns, placed between the boilers, which also supported the bunker and machinery housing. The shortening of the roof trusses reversed the stresses in some of the members and these had to be reinforced to take the new stresses. The lower portion of the bunker is a parabolic-shaped bag suspended by steel straps from the trusses which form the upper part. The straps are lined with an interlocking crimped plate known as "Ferro-Inclave." The construction of the bunker bags is simple. A layer of concrete is poured

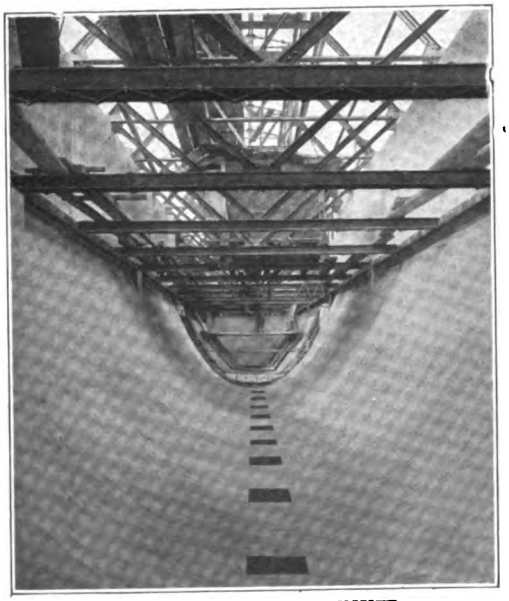

FIG. 27. INTERIOR OF BUNKER

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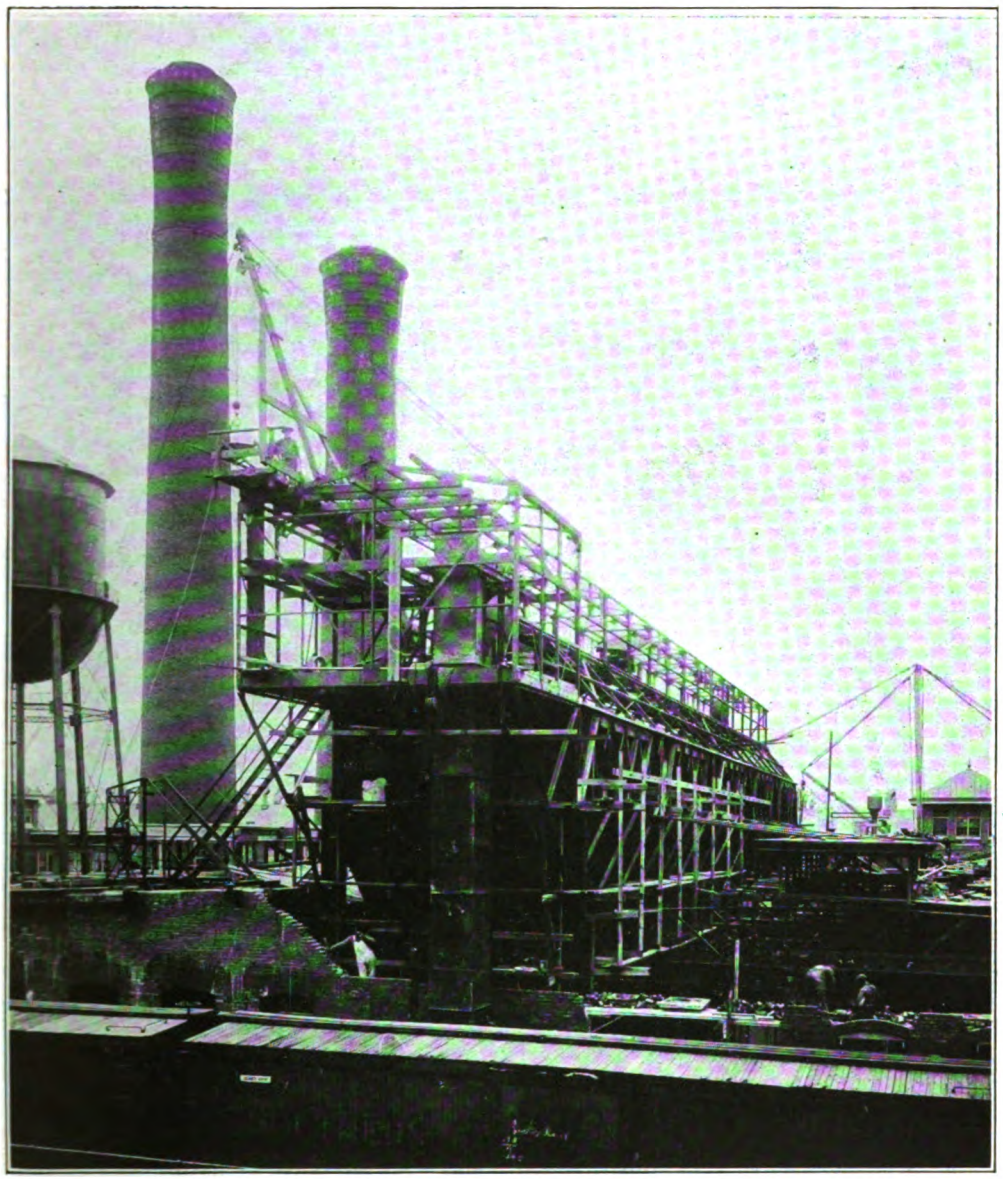

FIG. 28. 1500-TON REINFORCED CONCRETE BUNKER IN COURSE OF CONSTRUCTION AT THE RIVERSIDE AND DAN RIVER COTTON MILLS

on the inside of the sheets forming a slab with the ferro-inclave as re-inforcement. A coat of cement plaster is then applied to the outside, and the interlocking crimp of the metal dovetails the two coats together and makes the equivalent of a monolithic slab. Figure 27 shows the interior of the bunker with a portion at the far end in course of construction. This method of construction is protected by patents held by Mr. Alex. Brown of Cleveland, Ohio. In the upper portion the concrete was applied to metal lath fastened to the inside of the trusses. The capacity of the bunker is 1500 tons. Figure 28 shows the bunker in course of construction and

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FIG. 29. INTERIOR OF BOILER ROOM OF THE RIVERSIDE AND DAN RIVER COTTON MILLS

gives a good idea of the extent of the alterations. The panels of the main roof next to the bunker on either side were given a steep slope and fitted with ventilators and skylights. The well-lighted interior shown in Figure 29 is a result of this detail.

Coal is received on two elevated sidings at one end of the boiler house and is dumped into a timber track hopper. It is then conveyed by an apron feeder to a double-roll crusher which is located directly over the elevator boot. The space on either side of the track hopper is used for ground storage, the coal being dumped directly to the ground from cars on the elevated tracks. This coal is reclaimed by hand and delivered to an auxiliary hopper, shown in the diagram, located over the feeder at the ground level. A Link-Belt gravity discharge elevator and a Robins belt conveyor are used to deliver to the bunker. An automatic, reversible tripper, with a single discharge chute, distributes the coal evenly over the full length of the bunker. The capacity of this equipment is 60 tons per hour. The belt conveyor was in-

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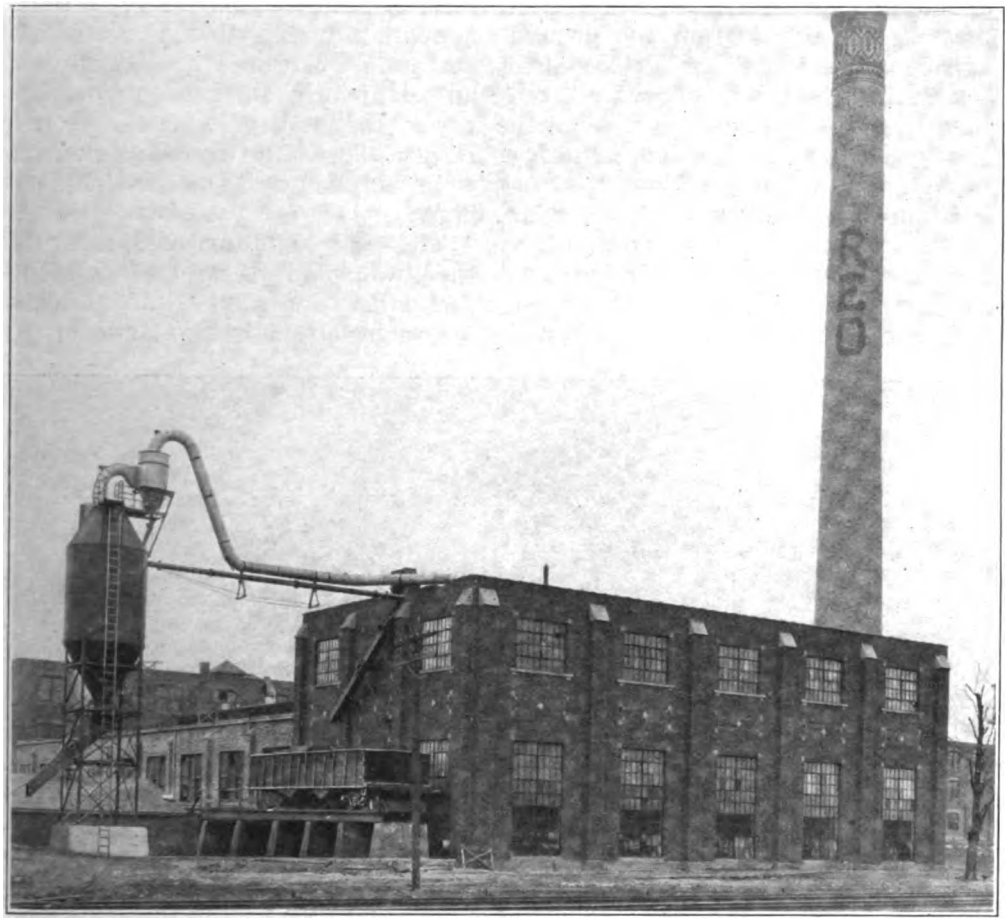

FIG. 30. NEW POWER PLANT OF THE REO MOTOR CAR CO., LANSING, MICH.
Darley suction conveyor ash-handling tank shown at the left.

clined at the loading end to reduce the height of the elevator and keep it from projecting above the monitor roof line. The boilers are equipped with underfeed stokers and the coal is delivered to the stoker magazines by a motor driven traveling weigh-hopper which may be seen in the illustrations. Ashes are handled by an eight-inch Darley suction conveyor, the outline of which may be seen in Figure 26. Detailed figures showing the saving affected by the remodeling of this plant were given in the first part of this paper last month.

In the new power plant of the Reo Motor Car Co. at Lansing, Michigan, a combination of centrifugal bucket elevator and flight conveyor is used to handle the coal supply. The present boiler rating of this plant is 2000 horsepower. A general view of the plant is shown in Figure 30. Coal is received on an elevated trestle at the end of the building and delivered into a hopper beneath the tracks; it is then elevated by a centrifugal elevator located just inside the building, and delivered either to the flight conveyor, which distributes to the bunker, or is by-passed to the pivoted chute which is seen suspended from the end of the building. This chute delivers to a ground storage space between the

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trestle and the ashes tank. The coal may be reclaimed from the ground storage pile by hand and delivered to the elevator by means of an auxiliary hopper at the ground level beneath the track-hopper. The coal handling capacity is 40 tons per hour.

Figure 31 is a view of the interior of the boiler room showing the 400-ton suspension bunker which is self-supporting and independent of the building structure. Coal is spouted directly from the bunker gates to the hoppers of the Jones under-feed stokers. The ashes are handled by an eight-inch Darley suction conveyor, the tank of which is seen in Figure 30. The mechanical parts were supplied by the Link-Belt Company.

The coal handling equipment for the power plant of the Ludlow Manufacturing Associates at Ludlow, Massachusetts, is rather unusual. An

FIG. 31. BOILER ROOM IN NEW POWER PLANT OF THE REO MOTOR CAR CO. Coal is spouted directly from the suspended bunker to the hoppers of the stokers.

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outline of the installation is shown in Figure 32. Coal is received on an elevated railroad siding outside the boiler house and is dumped directly from the cars to a ground storage pile. A tunnel is framed in between the trestle bents and contains a double-strand flight conveyor which delivers into a double-roll coal crusher. The conveyor is fed through gates in the side of the tunnel which may be controlled by an operator from inside the tunnel. From the crusher the coal is fed to a single-strand, centrifugal-discharge elevator which runs up outside the building and delivers to the hopper of a Richardson automatic scale, where the weight of the coal is automatically registered as it passes through at the rate of 50 tons per hour. From the scale the coal is fed to a single-strand flight conveyor, suspended beneath the roof trusses, and delivered directly to the stoker magazines. The boilers are equipped with over-feed stokers contained in Dutch ovens, and the sides of the coal hopper of each stoker have been built up to provide a small reserve storage for each furnace. The stoker siftings are collected and delivered to the elevator boot through an opening in the boiler room floor just inside the wall in back of the elevator. A by-pass chute is provided at the elevator head to allow these siftings to be delivered to the conveyor without passing a second time through the scale.

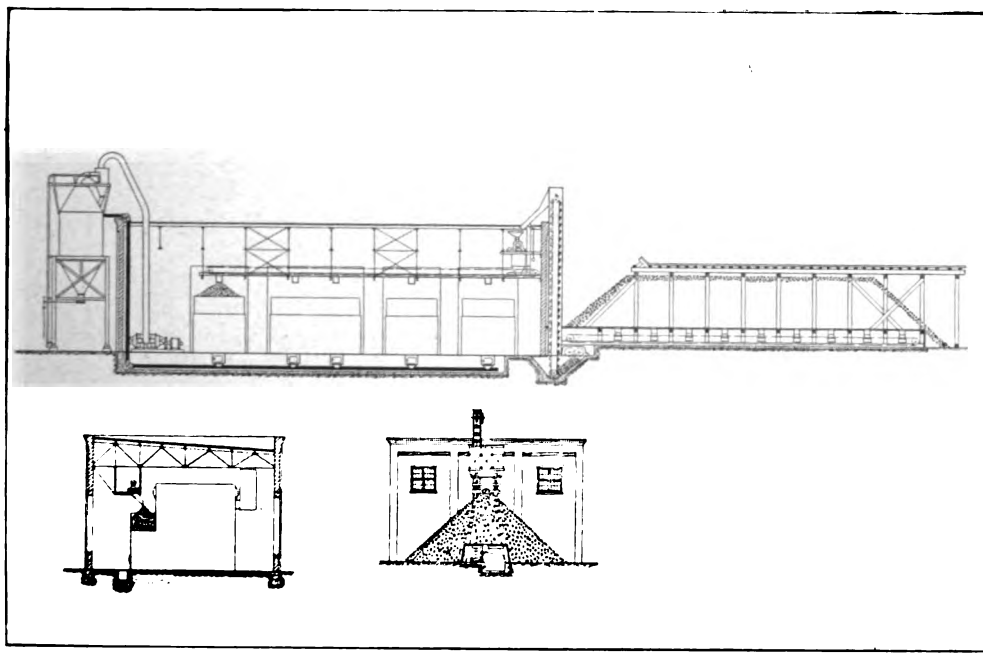

FIG. 32. COAL AND ASH HANDLING EQUIPMENT FOR THE POWER PLANT OF THE LUDLOW MANUFACTURING ASSOCIATES, LUDLOW, MASS.

The ashes are handled by an eight-inch Darley suction conveyor and delivered to a 30-ton tank over the railway siding. The output of the mills served by this plant is chiefly burlap, rope, cordage, and other similar products, and large quantities of this waste material are burned in the furnaces. This produces an excessive amount of exceptionally hard clinker which cannot be fed to the conveyor. To overcome this difficulty a reciprocating jaw crusher was placed over

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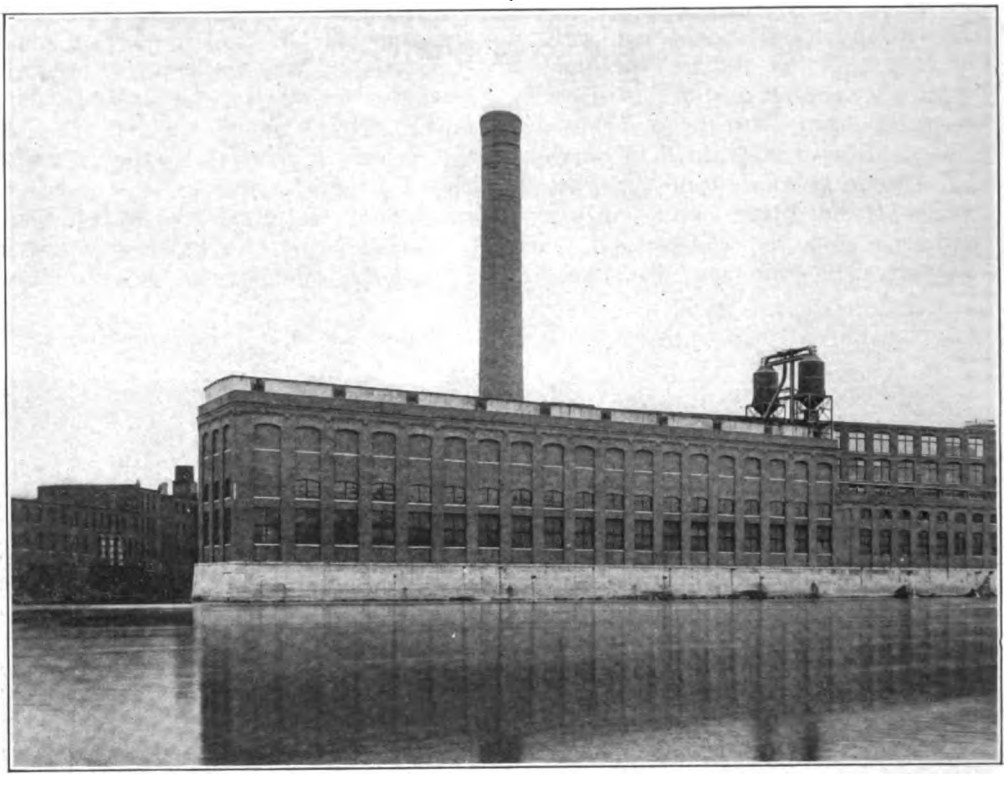

FIG. 33. POWER PLANT OF THE MASSACHUSETTS COTTON MILLS, LOWELL, MASS.

the conveyor pipe at one end of the building; the clinkers are taken from the furnaces, delivered to the crusher in wheel-barrows, and are discharged from the crusher into an opening in the conveyor duct. The plant is for auxiliary power only, and is operated during dry spells when the water power falls off. The boiler house was enlarged about two years ago and its capacity doubled. This necessitated the remodeling of the coal-handling equipment, and many parts which had been in service for several years were used again in the new installation. A steam-jet ash conveyor was removed and the pneumatic suction system installed.

The power plant of the Massachusetts Cotton Mills at Lowell, Mass., is an example of the pneumatic suction conveyor in its broadest application. A general view of the building is shown in Figure 33, the two receiving tanks of the coal conveyor are seen above the roof. The plant has a boiler rating of 10,000 horsepower, and a reserve storage bunker of 5500 tons capacity is incorporated in the structure of the building above the boilers. The diagram in Figure 34 shows in outline the coal and ashes handling equipment. Coal is delivered to a hopper beneath the railway siding 500 feet from the boiler house. It is then fed by an apron conveyor to a double-roll crusher. As it leaves the crusher it is shot into the intakes of the twin conveyor pipes by a specially designed belt feeder. After a short rise the pipes run for 500 feet above the roofs of intervening buildings and with another rise deliver to the receiving tanks almost 100 feet above the loading point. The capacity of each of these twin systems is

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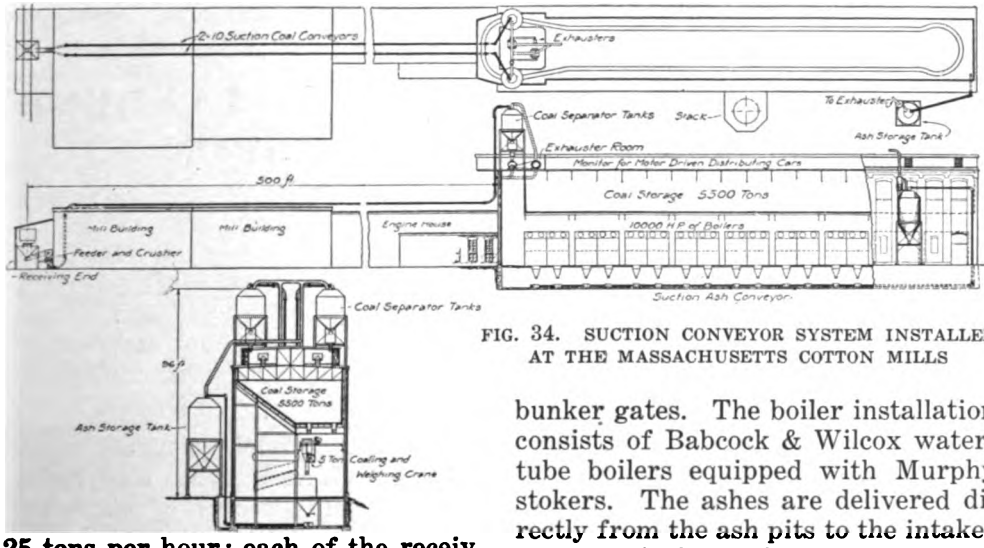

FIG. 34. SUCTION CONVEYOR SYSTEM INSTALLED AT THE MASSACHUSETTS COTTON MILLS

25 tons per hour; each of the receiving tanks has a capacity of 45 tons. The coal is distributed by five-ton motor-driven cars which operate on an endless track in the monitor above the bunker. An auxiliary tank was introduced between the receiving tank and the car, which may be seen in the diagram. With this arrangement part of the coal in the main tank can be discharged into the auxiliary tank below and from there to the cars after the gate in the main tank has been closed. Thus the coal can be discharged while the machine is in operation without materially lessening the pressure in the receiving tank.

Two huge positive blowers are located in a room partitioned off in the monitor and exhaust the air from the receiving tank through twenty-four-inch steel piping so arranged that either blower may draw from either tank. Before being released, the exhaust air is passed through an air washer and the dust is removed.

Coal is drawn from the bunker into a traveling weigh-hopper which distributes to the stoker magazines. This hopper is suspended from a crane within a crane which permits a short cross-travel to enable it to draw from either of the two lines of bunker gates. The boiler installation consists of Babcock & Wilcox water-tube boilers equipped with Murphy stokers. The ashes are delivered directly from the ash pits to the intakes of a ten-inch suction conveyor and carried to a 75-ton receiving tank at the side of the building at the rate of twenty tons per hour.

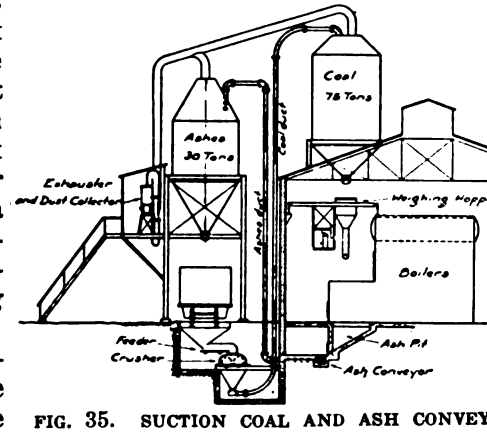

FIG. 35. SUCTION COAL AND ASH CONVEYOR

Figure 35 shows another application of the suction conveyor for handling both coal and ashes. It is a diagram of the installation at the Baldwin Locomotive Works at Eddystone, Pa. In this case the coal tank was made large enough to serve as a reserve storage hopper, and the coal is delivered directly to the traveling weigh-hopper which in turn delivers it to the stoker magazines in the boiler room.

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THE INFLUENCE OF DIFFERENT ELEMENTS ON THE CORROSION OF IRON

By L. C. Wilson

In a series running through the pages of this magazine from January to May of this year on The Corrosion of Iron, Mr. Wilson discussed the general problem of rust formation, theories as to its causes, protective coatings, paint materials, and paints. The present article describes the effects toward non-corrosion of the addition of various alloys in iron and steel; following this, next month, he presents a paper on The Corrosion of Wrought-Iron and Steel Pipe.—THE EDITORS.

IT has probably occurred to everyone who is forced to rely on protective coatings of one sort or another to keep iron and steel from rust and decay that this method of combating the corrosion problem is of the same order as locking the barn door after the horse is stolen. In other words, since rusting is a consequence of the tendency of iron to go into solution when in contact with water, why not add something to it or treat it in some way so as to eliminate or decrease this tendency? An enormous amount of labor and material, to say nothing of time, is used up every year in coating and protecting iron from adverse conditions and with the rapid increase in the demand for this metal a correspondingly greater amount of labor, material, and time is required. Obviously, any procedure which would lessen the need for such thorough protection would be a very real saving.

Definite work along this line is of comparatively recent date and the available information is perhaps not as complete as could be wished, but enough has been done to throw some light on the possibilities of ultimate success and enable us to use to good advantage some of the facts which have been obtained.

In effect, of course, the problem resolves itself into the study of the influence of the various elements, meaning the different metals and metalloids, on the process of corrosion. Chemically pure iron is little more than a laboratory curiosity; certainly it is not available for commercial use in building bridges and sky-scrapers and experiments have shown on the whole that it is very little or no more resistant to corrosion than well made wrought iron or steel; so the answer to the problem does not lie in this direction, although this should not be taken to mean that any pains are to be spared in making iron and steel of high purity and as free from segregation as possible. Perhaps a better idea of the difficulties presented in accomplishing these may be obtained by reviewing briefly the early stages of the manufacture of iron.

This metal is found in nature principally in the form of the oxide and by far the largest part of the ore is smelted in blast furnaces, which are a sort of immense stove, 75 or 100 feet in height. The ore, mixed with coke —more rarely with charcoal or coke and anthracite coal—and enough flux, generally limestone, to remove some of the impurities in the form of slag or cinder, is charged in at the top. Air heated to a temperature of several hundred degrees centigrade is forced at a pressure of about 15 pounds per square inch into the fur-

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nace near the bottom, through pipes known as tuyéres. This blast is further heated by the combustion of the fuel and passes up through the charge, melting and reducing the ore. The metallic iron thus formed trickles down and collects on the bottom of the hearth, with the cinder floating on top of it; the furnace is tapped at intervals of several hours and the iron cast into pigs or sent to the steel mill where it is purified, as will be described in another article. The cinder is allowed to escape at longer intervals.

The iron produced in this manner is a comparatively impure material since it contains very considerable amounts of carbon and silicon, especially, and less of manganese, sulphur, and phosphorus, with varying quantities of several other elements, depending on the character and quality of the ore. Altogether, these impurities will amount to six or seven per cent. Pig iron is melted and cast into various forms, constituting the gray or cast iron of the foundry, but it can not be rolled or otherwise worked without further treatment. Omitting for the present the details of this, the product is known as wrought iron or steel, which latter is a rather indefinite term. In these, however, the percentage of other elements will generally be well under one per cent, except where one or more of them is added purposely, as in making alloys, or for conferring certain desirable characteristics. It is impossible to remove all of the sulphur, phosphorus, and so on, and if the attempt is made to do so the iron itself undergoes considerable oxidation, the oxide present mingling with the molten metal and introducing a new and perhaps greater danger.

All of the ordinary impurities in iron, with the exception of manganese, are electro-negative to it, which means that a current will flow from one to the other in the presence of an electrolyte. Under such circumstances the solution of the iron will be hastened, as explained in a previous article,* and it will corrode much more quickly. It is in a way reasonable, therefore, for the idea to have arisen that the purer steel and iron can be made, the less subject to corrosion they will be, thus rather tactily blaming the tendency to rust on the inherent impurities of the iron. Without stopping to discuss the soundness of this view, the fact remains that it is not practicable to refine iron beyond a certain point, hence experiments have been tried to ascertain the effect of adding other elements beside those usually found in iron in the hope that in some way the end desired might be accomplished by this means.

Taking up first the normal constituents of iron and steel: It appears from the data at hand that silicon rather tends to increase corrosion, although this is contrary to what might be expected, as it is well known that iron high in silicon is markedly resistant to acid attack. It is generally agreed, however, that the resistance to acid is not always a reliable measure of corrodibility since many discrepancies are observed, and perhaps this is one of them. The silicon content of ordinary steel is not very high, so this element when present in normal amounts probably exerts little effect as far as corrosion is concerned, but even if it did have an inhibitive action it could hardly be used in any quantity as it renders steel weak and brittle.

Sulphur is harmful in its effects, materially increasing the tendency to corrode; even fairly small amounts exert an appreciable influence in this direction.

* THE ENGINEERING MAGAZINE, Vol. 48, p. 667, *et seq.*

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Manganese is popularly supposed to be the cause of much trouble, and the supposedly greater resistance of the older irons over modern steel has been largely ascribed to their low content of this metal. Recent work, however, shows that it does not play as important a part as has been thought. In the tests conducted by Burgess and Aston the results were not altogether consistent, but in general it appeared that atmospheric corrosion increased with higher manganese content, although in all cases this was less than that observed for pure, electrolytic iron. On the whole, probably, the influence of manganese, unless it is present in amounts greatly in excess of what would ordinarily be the case, may be considered as practically negligible; at any rate its action is not strongly marked one way or the other.

Phosphorus seems to exert a beneficial effect, rather than otherwise, when present in reasonable quantities. Of course, the phosphorus content of a steel affects the physical properties greatly and the permissible amount is low; specifications are usually very strict on this point.

Carbon is another element which determines to a large extent the characteristics of iron and steel and the amount allowable is rather limited, but from the work of some investigators it appears that in annealed steels carbon up to about 89 per cent increases corrosion, which then falls off with higher carbon content. In quenched and tempered steels no point of maximum corrosion could be located up to 96 per cent carbon as it was increasing with rising content of the latter. The effect of varying amounts of some of the other normal impurities of iron has not been studied in detail, but on the other hand it is rather doubtful if results of any particular value would be obtained. These metals and metalloids are always present to some extent in iron and steel; to remove them entirely is very difficult if not impractical commercially; in any case the weight of evidence goes to show that pure iron corrodes, in the long run, at a rate little or no different from an ordinary, commercial grade of material, assuming that this is well made and reasonably free from segregation. The point is that none of these elements, with the possible exception of sulphur, appears to exert any particular influence either good or bad on the process of corrosion when they are present in the amounts permissible from the standpoint of the physical properties which they confer. There seems to be no reason to hope, therefore, that any benefits will accrue either from removing them completely or increasing the amount of any or all of them over that usually met with.

Some time ago Burgess and Aston carried out experiments on the alloys produced by adding various quantities of different metals to electrolytic iron, that is, iron which had been deposited from a solution of a salt of this metal by means of the electric current and therefore of great purity. Care was taken to exclude impurities as far as possible in making up the samples, and after the alloys had been brought into proper shape for testing small pieces were exposed to the weather for something less than six months; then they were cleaned and the loss in weight noted, after which an accelerated acid corrosion test was applied.

Before considering the results it may be noted that these tests were not made on a commercial grade of iron, (the electrolytic material being practically free from carbon, silicon, manganese, sulphur, phosphorus, and other impurities so that the effect

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of these was lost), but while this may be objectionable in some ways there is little doubt that the results indicate, in a general way at least, the influence of the metals tested.

In trying out various grades of commercial irons of different degrees of purity, it was found that some corroded more, some less, than the electrolytic iron; the samples of the latter representing an average product, as far as composition is concerned. In its ability to withstand acid attack or atmospheric corrosion it did not stand out at all prominently. These results are in general accord with those obtained by other investigators; that is, on very pure iron rust may be somewhat slower in starting than with the ordinary varieties, but the difference in behavior soon becomes negligible, and in the course of an exposure test covering several months it appears that there is no decided superiority one way or the other.

A sample of pure iron containing 1.33 per cent of aluminum showed a slightly decreased tendency to corrode in the air, but was more easily attacked by acid. Neither it nor another sample containing a much smaller amount of aluminum gave results of any particular interest.

Arsenic confers no especial resisting power against atmospheric corrosion, even when used in amounts up to 3.56 per cent. It is well known that this metal is an objectionable impurity in sulphuric acid pickling solutions as it slows down the action considerably, and it has been thought that something of this sort might be exhibited when it is alloyed with iron, but apparently the reverse is true since the rate of solution in acid becomes higher with larger amounts of it present.

In any case iron-arsenic alloys possess undesirable qualities, aside from the fact that they are rather difficult to make, such as weakness and brittleness, which would render them unsuited for structural purposes.

In like manner the alloys with cobalt do not present any unusual characteristics. The resistance to acid attack increases with higher cobalt content and this is true of the behavior of the specimens exposed to the weather. As in the case of arsenic, considerable percentages of cobalt would be required to produce an alloy having sufficient resistance to corrosion to be of much value. The comparatively high cost of the metal is one objection to the use of such alloys, and, further, the addition of such large quantities of it changes the properties of iron and steel more or less profoundly and takes us into the realm of special steels. This is also true of several other metals besides cobalt.

The addition of nickel gives results somewhat similar to those obtained with cobalt; perhaps this might be expected in view of the close chemical relationship between the two metals. Nickel, however, confers very fair resistance to both acid and atmospheric attack and this corresponds in a general way to the amount of this metal present. As in previous cases, however, a fairly large amount of nickel is needed, one per cent or over, to produce very decided results from the standpoint of corrosion, and this increases the cost while altering the physical properties as well; up to about 3.5 per cent it gives greater strength, raises the elastic limit, and promotes soundness. Iron-nickel alloys have properties which have been found of value for certain purposes, but it is rather doubtful if they come into wide use for general work solely on the score of decreased corrodibility.

Experiments with silver, tin, tungsten, and selenium indicate that these

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elements when alloyed with iron do not alter very much its tendency to corrode. In the case of silver and selenium, the alloys contained only small amounts of these metals and it would be unwise to attempt to draw very definite conclusions as to their action. In any event it is not likely that either would be used very widely on account of their cost.

With both tin and tungsten there is a tendency toward increased resistance to atmospheric corrosion as the content of these metals in their respective alloys becomes greater, but it is nothing remarkable at any time. The alloys with low tin content display very good resistance to acid attack but this decreases appreciably with the higher alloys. The corresponding figures for tungsten show up well, but they are irregular and lack consistency. As in the other instances, these metals, to be of much effect, would have to be added in amounts which are sufficient to change the properties of the iron markedly; in general, the iron-tin alloys are brittle and lack strength, while those with tungsten are noted for their great hardness and are used under the name of high-speed tool steels. Obviously they would be unfit for ordinary purposes, aside from cost considerations.

Copper may be regarded as a normal constituent of iron and steel, although it is sometimes present only in the barest traces; but the effects which even small additions of it produce are remarkable and a considerable amount of very careful work has been done in investigating the possibilities which it presents along the line of reducing the tendency of iron to corrode at the least opportunity. The results are so interesting that they are worth considering in some detail.

As long ago as 1901 two experimenters, Stead and Wigham, made some tests on copper- and non-copper-bearing steels and came to the conclusion that, under the conditions of their tests at least, the steels with copper showed up to better advantage. Within the last few years, however, other experimenters have taken up this subject and of these Buck has probably done more than any one else and his work merits more than passing attention.

In a paper read before the annual meeting of the American Chemical Society at Milwaukee, March 25, 1913, he gave the following information regarding the preparation of the samples and the method of conducting the tests:—

"In order to avoid the possible uncertainty in comparing different heats of steel with and without copper, and in order that the conditions, except the copper content, should be identical, it was decided for these comparisons to copperize portions of heats, leaving other portions of the same heats in their original conditions.

"Three heats were used. One a regular basic open hearth of the following analysis:

Carbon	Manganese	Sulphur	Phosphorus
0.10	0.34	0.034	0.019

"A second basic open hearth heat was re-phosphorized, giving this analysis:

Carbon	Manganese	Sulphur	Phosphorus
0.13	0.45	0.036	0.042

"The third heat was regular Bessemer steel of the following analysis:

Carbon	Manganese	Sulphur	Phosphorus
0.08	0.46	0.070	0.096

"In pouring the open hearth heats several ingots were first poured without the introduction of copper; then

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to four ingots sufficient copper was added to obtain in two of them about 0.15 per cent, and the other two about 0.25 per cent copper in the finished product. The Bessemer heat was treated in exactly the same way, except that, since the average Bessemer heat is too small to furnish six ingots of the size desired, only two ingots were copperized, aiming at the same contents as in the case of the open hearth. The copper was added to the moulds a little at a time as they were filling, and that the resultant steel was uniform in its copper content, was demonstrated by many analyses of the bars and of the finished sheets. Indeed, that copper easily diffuses through the bath of molten steel, and does not segregate on cooling, is a well established fact.

"Six ingots were then taken from each of the open hearth heats, two plain, two with 0.15 per cent copper and two with 0.25 per cent copper, and three ingots from the Bessemer heat, one plain, and one with each content of copper.

"The fifteen ingots thus prepared were carried through the usual mill operations, each bar as cut and each sheet as rolled being chalk marked so that no confusion could possibly occur, and in the end each lot was again carefully analyzed as a double check on the operations.

"One ingot of each grade of open hearth was rolled into 16-gauge and the other into 27-gauge sheets, 30 by 96 inches; while in the case of the Bessemer steel, one-half of each ingot was rolled into 16-gauge and the other half into 27-gauge sheets. All grades were subjected to exactly the same treatment, being rolled by the same crews, and annealed in the same furnace at the same time, and the finish was such as to conform with that of the competitive sheets used in this test. From 24 to 36 sheets of each of the nine grades, both gauges, making 18 lots in all, were then sheared to 24 by 96 inches, thus obtaining a strip 6 inches wide from each sheet. These strips were sheared into 2 by 4-inch test pieces, stenciled with distinguishing marks, and were used for corrosion tests which will be described later. The 24 by 96-inch sheets were corrugated in the usual way, and eight to twelve sheets of each grade shipped to each of three testing stations. One of these is located in the Pennsylvania coke regions, where the air contains notable amounts of sulphurous and sulphuric acids and other fumes from the coke ovens. In this district iron and steel, unless protected, corrode very fast. Another station is located on the sea coast, where the air carries sodium chloride. The third is in a rural community, where the air is quite pure and free from added corrosive agents."

A sloping wooden framework was erected at each place and the sheets fastened thereon, with precautions to see that the drip from one sheet did not fall on the next one below. They were thus held several feet from the ground, so that there was a free circulation of air on all sides, and exposed to the weather without a protective coating of any sort except the thin film of oxide normally present on the surface of black sheets.

There were likewise exposed at the same time and under the same conditions sheets of both 16 and 27 gauge, purchased on the open market, showing the following average analysis:

Carbon	Manganese	Sulphur	Phosphorus	Copper
0.02	0.03	0.034	0.003	0.06–0.07

All of the sheets were placed in position during November, 1911, and were frequently inspected; by means of the small test pieces cut from the

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large sheets and exposed at the same time, it was possible to determine the loss of weight of each grade.

First, considering briefly the results of the examinations of the large sheets after varying periods of exposure, at the end of seven months in the coke regions the Bessemer steel sample without copper had failed entirely, while those from the same heat but with copper additions were in very good condition. The same thing was true of the basic open hearth steels, the copper bearing samples showing up well, while those without it had failed. One from a re-phosphorized heat, but containing no copper, was in somewhat better condition than the corresponding panels from the other heats, although it was showing the effects of corrosion, while the copper bearing panels were in good shape.

It was noted that the color of the oxide on the non-copper steels was bright red and loosely adherent. The copper steels were dark brown and the oxide adhered tenaciously.

An inspection several months later disclosed that the steels without copper had failed completely and had fallen to the ground, while the copper steels were still in fair shape. The low carbon and manganese material, American ingot iron, was in rather bad shape and after about eighteen months of exposure had disappeared entirely, although all of the copper bearing sheets were still in place.

While the samples at the sea-shore exhibited relatively less rapid corrosion than those in the coke regions, the same differences in the behavior of the copper and non-copper steels were shown here as in the other case. In something less than two years all of the normal steel samples had failed completely, which was also true of the American ingot iron, with the exception of two sheets, while the copper bearing steel panels were still intact.

At the test station located in the country district, too, the copper steels showed up to approximately the same advantage over the normal materials

SAMPLES EXPOSED IN COKE REGIONS NOV. 21, 1911 TO AUG. 14, 1912

Grade	Gauge	ANALYSIS Carbon	Manganese	Sulphur	Phosphorus	Copper	Relative losses, 100 equals greatest corrosion
Bessemer	27	.05	.44	.082	.101	.23	39.09
Bessemer	27	.05	.44	.075	.099	.34	39.61
Bessemer	16	.07	.46	.069	.095	.33	41.57
Open Hearth.....	27	.10	.46	.035	.043	.17	42.09
Open Hearth.....	27	.07	.47	.038	.043	.25	42.22
Open Hearth.....	27	.06	.33	.035	.018	.25	43.27
Open Hearth.....	27	.06	.35	.036	.018	.16	43.92
Bessemer	16	.08	.45	.070	.094	.21	44.05
Open Hearth.....	16	.14	.46	.038	.043	.27	46.67
Open Hearth.....	16	.13	.44	.035	.042	.18	46.67
Open Hearth.....	16	.10	.35	.033	.019	.23	47.32
Open Hearth.....	16	.10	.34	.035	.020	.16	48.36
Low C and Mang..	27	.02	.03	.036	.003	.07	50.19
Low C and Mang..	16	.03	.03	.034	.003	.06	53.20
Open Hearth.....	16	.13	.45	.035	.042	.00	74.64
Open Hearth.....	27	.09	.47	.037	.043	.00	78.16
Bessemer	16	.08	.46	.070	.098	.00	91.64
Bessemer	27	.05	.45	.076	.100	.00	96.86
Open Hearth.....	16	.10	.34	.034	.019	.00	98.82
Open Hearth.....	27	.06	.35	.033	.018	.00	100.00

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SAMPLES EXPOSED AT SEA SHORE NOV. 28, 1911 TO SEPT. 7, 1912

Grade	Gauge	ANALYSIS Carbon	Manganese	Sulphur	Phosphorus	Copper	Relative losses, 100 equals greatest corrosion
Bessemer	27	.05	.44	.075	.099	.34	51.12
Bessemer	27	.05	.44	.082	.101	.23	51.12
Open Hearth.....	27	.07	.47	.038	.043	.25	51.96
Open Hearth.....	27	.10	.46	.035	.043	.17	55.03
Open Hearth.....	27	.06	.33	.035	.018	.25	55.59
Bessemer	16	.08	.45	.070	.094	.21	56.42
Bessemer	16	.07	.46	.069	.095	.33	56.70
Open Hearth.....	16	.10	.35	.033	.019	.23	57.54
Open Hearth.....	16	.13	.44	.035	.042	.18	58.94
Open Hearth.....	27	.06	.35	.036	.018	.16	58.94
Open Hearth.....	16	.14	.46	.038	.043	.27	60.90
Open Hearth.....	16	.10	.34	.035	.020	.16	64.81
Low C and Mang..	27	.02	.03	.036	.003	.07	64.81
Low C and Mang..	16	.03	.03	.034	.003	.06	65.37
Open Hearth.....	27	.09	.47	.037	.043	.00	65.60
Open Hearth.....	16	.13	.45	.035	.042	.00	70.39
Open Hearth.....	27	.06	.35	.033	.018	.00	87.99
Open Hearth.....	16	.10	.34	.034	.019	.00	88.83
Bessemer	27	.05	.45	.076	.100	.00	98.32
Bessemer	16	.08	.46	.070	.098	.00	100.00

SAMPLES EXPOSED IN COUNTRY DEC. 3, 1911 TO NOV. 16, 1912

Grade	Gauge	ANALYSIS Carbon	Manganese	Sulphur	Phosphorus	Copper	Relative losses, 100 equals greatest corrosion
Open Hearth.....	27	.06	.35	.036	.018	.16	51.89
Bessemer	27	.05	.44	.075	.099	.34	52.69
Open Hearth.....	16	.10	.34	.035	.020	.16	52.69
Bessemer	27	.05	.44	.082	.101	.23	53.88
Bessemer	16	.07	.46	.069	.095	.33	54.67
Open Hearth.....	27	.06	.33	.035	.018	.25	55.07
Open Hearht.....	27	.10	.46	.035	.043	.17	55.27
Open Hearth.....	16	.13	.44	.035	.042	.18	55.27
Open Hearth.....	27	.07	.47	.038	.043	.25	55.67
Open Hearth.....	16	.10	.35	.033	.019	.23	55.87
Bessemer	16	.08	.45	.070	.094	.21	57.26
Low C and Mang..	16	.03	.03	.034	.003	.06	57.46
Open Hearth.....	16	.14	.46	.038	.043	.27	58.25
Low C and Mang..	27	.02	.03	.036	.003	.07	64.42
Open Hearth.....	16	.13	.45	.035	.042	.00	68.79
Open Hearth.....	27	.09	.47	.037	.043	.00	71.77
Open Hearth.....	16	.10	.34	.034	.019	.00	76.54
Bessemer	16	.08	.46	.070	.098	.00	90.26
Open Hearth.....	27	.06	.35	.033	.018	.00	90.66
Bessemer	27	.05	.45	.076	.100	.00	100.00

as at the other stations. Space does not, however, permit of a detailed discussion of the results of the inspections and in any case a clearer idea of the showings of the various materials under test may perhaps be obtained from a consideration of the results obtained on the small test pieces. It may be noted that each result in the preceding tables is the

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average of six pieces; as mentioned previously these were 2 by 4 inches.

These results need no comment or explanation, but it is apparent that some progress in the right direction has been made. Whether it will be possible sometime so to alter the characteristics of iron, by the addition of some other metal or combination of metals, that it will not rust at all or only with difficulty, and at the same time not change its mechanical properties objectionably, seems to be doubtful, although further advances along this line will probably be made as time goes on.

Just now, the best available material of this sort is copper bearing steel, which is finding a wide and rapidly growing use; anyone can make it and the present output is very large.

How to Secure Foreign Trade

*By Frederic Schreibman**

Beginning in the August number Mr. Schreibman has given a series of essays for the benefit of American manufacturers who are interested in promoting the sale of their products abroad. He first discussed the methods that have been so successfully employed by Germany; last month he described some of the vicious foreign business methods which must be combated; this month he outlines present unsatisfactory selling systems—small dealers and commission houses. A concluding essay will present a plan for the organization of an export league of small manufacturers.—The Editors.

At the beginning of these essays I stated that I expected to write particularly for those manufacturers who have not yet had an opportunity of trading with Europe, and who are not acquainted with the conditions that underlie successful trade with Europe. To such a manufacturer I would ask, "What result are you expecting to realize?" The answer would be, of course, that he expects to make himself known, to sell as much goods as possible in the shortest space of time and with the least expense, and to have at his beck and call the very best advice obtainable that he may not fall into the hands of insolvent purchasers, incapable agents, or incompetent employees.

The manufacturer ordinarily sells his products to his customers in either of two recognized ways: First, he may do it through agents whom he has appointed; or second, he may turn the sale of his goods over to a middleman, who is free to work in his own manner, with whom and when he chooses. By following the first plan the manufacturer will obtain excellent results if his sales force is logically and rationally organized (such sales systems unfortunately are rarely found). But as this method can only be set up at great expense it is usually only employed by large manufacturers; if then, the small manufacturer cannot have his own sales force, he must confide in middlemen. Of these there are two kinds: the small wholesaler who works on his own account, or an incorporated stock company which often possess great power.

My aim in writing these articles is to advise small manufacturers who desire export trade to use a third method which combines the advantages and avoids the disadvantages of either of the above-mentioned selling

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plans. The merit of this method lies not in its novelty but principally in its logic.

Before this method is described it would be well to study manufacturers, small wholesalers, and incorporated commission houses, and uncover their usual manner of thinking, planning, and acting, and the changes which should be made in their sales methods.

The Small Manufacturer

The small manufacturer will be found generally to be a self-made man. Little by little, through hard conscientious work, by perseverance and intelligence he has been able to increase the size and standing of his plant. "His" plant! The word "his" is all important. It implies that our manufacturer sees a part of himself in every corner of his factory. No extensions have been made, nothing has been changed or renewed without his consent; he was there to be consulted and to give orders. No work has been carried out, no machine tool bought, no reserve made for depreciation, without a personal struggle on his part. He began, perhaps, alone in a tumble-down building practically rent free. He has grown slowly, and at last finds himself at the head of a plant seemingly perfectly organized. His product has an established reputation and is still bought by those who gave him his first orders. His customers may be limited, but they are sufficiently numerous to encourage him in the future. This analysis holds whether there be a single owner, or a group of owners.

We will suppose his plant to be in New England. He makes steam engines, machine tools, moulding machines, wire rope, or any other kind of product. We will suppose that he has never sold any of his products outside of his own country, and that a letter from a foreign agent has been written to him somewhat as follows: "We understand that you wish to export. If such is the case, will you kindly inform us what grade of articles you manufacture, what rights you withhold, and what commission will you pay on sales?" In all probability he will answer: "I make such and such an article; my work is exceedingly good; and my prices are very reasonable—perhaps they are a little high but I will guarantee the quality to be better than my competitors. My sales conditions are 10 per cent off list price, cash down, unless the purchaser's rating is good, in which case I will allow an additional discount of 2 per cent in 30 days. I will pay a commission to a wholesaler, or will sell to him at such and such a price. What profit he may make will be his own."

These are about the thoughts of most manufacturers. It makes no difference what part of the globe they live in they think their product is the best of its kind and would impose their sales conditions unqualifiedly. Their wholesaler must submit to these conditions. We shall see what such a course leads to.

The Small Wholesaler

The first person with whom the manufacturer comes into immediate contact and who is to be his co-worker is the middleman. As I have already stated, the middleman may be either working independently or he may represent an incorporated agency.

In every industrial center one finds such a wholesale house. Its proprietor may not be well supplied with capital, never with very large capital, but to make up for this he will, generally speaking, be found to be honest, energetic, and intelligent. He may be, perhaps, four-fifths engineer and one-fifth merchant, or the reverse. He sells one or two specialties, at most five. He works in a radius

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around his own home city, and is well acquainted with everybody in the trade. He will know, or should know, how to deal with any particular customer in order to get his trade. Let us now suppose that such a small dealer asks a manufacturer for exclusive territory for his product. Will we need to ask what answer he will receive? Certainly not. The result would be absolutely nothing. Because, primarily, the small manufacturer has no very great confidence in the small middleman. It is human nature that those who have achieved a small success hold other small successes in distrust. They would greatly prefer being represented by a larger house. The manufacturer will say, "All that you have to do to introduce my product is to tell your prospective purchaser that I manufacture an excellent article, better than any of my competitors; my prices are reasonable, and you will find that the sale is already half made." The manufacturer will not understand that it is exceedingly difficult to sell any article which bears an unknown trade mark. Such an article may be as perfect and cheaper than another article exactly similar but bearing a well known trade name. The purchaser or prospective purchaser becomes distrustful and refuses to buy. It is quite possible that if the purchaser were offered a hundred pieces, all made in the same factory, manufactured in the same manner, exactly similar in every respect, but half of them marked with a well known trade name and the others carrying an unknown name, he would willingly pay any price asked for the first lot and absolutely refuse the second lot at any price. Such being the case we are justified in drawing the conclusion that what is actually purchased is the trade mark, and what is to be built up is perfect confidence.

This condition will last as long as the purchaser himself does not know and cannot verify the quality of the product offered him. Even if he does fully recognize the value of the product a sale will not always follow, because he will not know that the product of a competing company is either inferior or dearer; or, again, it is quite possible that side issues of a personal or even illegal nature will govern the sale. I shall touch upon this last feature later on.

It is evident that the ideas of the ordinary manufacturer may often be wholly erroneous as to the ease with which his goods may be sold.

But, if the product that one wishes to introduce into a foreign market is of superior quality and is offered at a reasonable price, it will be more easily sold, even though a similar product is already largely used, if there is plenty of money available when and where wanted; if the manufacturer and middleman agree as to the value of product and method of sale; and if they both possess enthusiasm, energy, and patience.

Neither manufacturer nor dealer have backs strong enough to bear all the costs of introducing a new product on the market, but we will suppose that the manufacturer does decide to employ the services of a small middleman. I do not ask upon whom the sacrifices of such an arrangement will fall, whether manufacturer, or middleman, or both, but I will only ask how the small dealer will begin and what his first step will be. It is evident that he cannot carry on business like the small grocer on the corner and wait patiently until some one comes to him for a steam engine, a pump, or a dynamo; but if he expects to do business at all he must spend considerable money: to introduce his goods by a publicity campaign—catalogues, advertisements in newspapers

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and magazines; for rent, office expense, salaries, etc., and for the maintenance of stock. It is absolutely necessary to have stock on hand, and the greater the distance between manufacturer and middleman, the larger the stock, therefore, American exporters must reconcile themselves to the fact that they must carry a heavy stock in Europe unless they find it more profitable, as some companies have found it, to conduct a separate manufacturing plant in Europe. The middleman must give his whole time to the business. Only by great sacrifices of time and money can he make much headway or attain success against an already established competitor.

How many manufacturers know how to make a catalogue, or how to write an advertisement? How many of them know how to offer their goods for sale in the best way possible? How many know how to find out the standing of a purchaser? How do they select their dealers? Under what conditions and on what kind of a basis must they work with their dealers, or with the customers of the dealer? All these problems will be too much for the manufacturer to solve, but very few indeed will acknowledge this. The majority think it quite sufficient to tell their dealers or their own agents, "These are my catalogues, my prices, my discounts, and my conditions. Go and get orders." This done, they think their responsibility is ended, and when orders are obtained they appreciate the fact that they have received orders; when no orders come they realize that condition, but they are unable to answer the questions: Why have orders come in? whose efforts brought them? what shall we do to insure future orders?

Perfect agreement between the manufacturer and the dealer on the subject of sales is not always easily achieved. It often requires a long time to settle disputed points; sometimes the manufacturer is at fault, and sometimes the dealer. It is interesting to note what some typical points of difference the courts have been called upon to decide. Here is one instance:

A dealer struggled desperately for a long time to introduce an unknown product. Little by little he gained a foothold. Finally he succeeded in placing his goods with a few purchasers and was rejoiced at receiving orders. The first orders were placed in his name; later the purchaser entered into direct relations with the manufacturer and ordered the goods sent to him direct. Bills were payable to the manufacturer and whatever losses arose were sustained by him. The purchaser was satisfied and continued to order directly from the manufacturer without passing them through the dealer. Very often the dealer was not even notified that an order had been sent or received. The court was called upon to decide whether the dealer was entitled to commissions on these sales. The manufacturer considered such a settlement unjust as the middleman did not place the orders; the middleman on the other hand had an entirely different idea of the word injustice.

Here is another case: Business had been very prosperous with a certain manufacturer and he received more orders than he could fill. Believing that the demand warranted it he increased his price above that asked when he had fewer sales. This displeased his customers. It may be that the plant did not increase in capacity in proportion to the increased number of orders and the manufacturer was, therefore, unable to deliver on the dates promised, or, perhaps, because of the increased orders he paid little

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attention to quality. At any rate disputes immediately arose between the manufacturer and his customer. The latter either refused to accept the goods sent or refused to pay any bill except with a heavy discount. The dissatisfied purchaser, consequently, not only will send no more orders, but tells his friends of his difficulties with the manufacturer represented by such and such a dealer. This naturally has led to a falling out between dealer and manufacturer, and the former enters claims against the latter.

The trouble is not always on one side, however, dealers themselves are not always whiter than snow. We have seen from cases decided by foreign courts that some dealers have not hesitated to embezzle payments due the manufacturer; or that the manufacturer himself has put up large sums to introduce his product, in which the dealer has taken no part, but has demanded his commissions just the same.

Some dealers do not know how to obtain orders; no one ever took the time to teach, guide, or direct them. Very often such men work blindly. If they are asked, "Who do you intend calling upon to-morrow?" or, "Do you know anything about the business of the man that you are about to see, what hours he receives callers, how he is to be approached, or what credit he deserves?" they will give vague and uncertain answers. But, on the other hand, if such a man is asked the address of a good restaurant where a good lunch or dinner can be obtained, or, where a good game may be found, he can give most precise information. It is quite evident, therefore, that misunderstandings are, as said before, sometimes the fault of the manufacturer, sometimes the fault of the dealer, and sometimes the fault of both. From lack of confidence and mutual esteem a permanent hostility may arise, which is often very serious and hurts equally the reputation of the article, the manufacturer, and the dealer.

Commission Houses

With few exceptions the history of an incorporated commission house is as follows: A small dealer has gradually built up a successful business. He takes as partner a man who has money, and together they change the business into an incorporated company. The original dealer becomes a director and acquires thereby name and connections which he did not formerly possess. He is no longer obliged to wear out shoe leather running from plant to plant, and no longer spends long hours waiting to be received. Instead, he is requested to write and send his catalogue. As an influential business man he makes his visits in an automobile, and is immediately received, not by some clerk, but by a member of the firm. If by chance he does have to wait he is shown into the directors' room and treated as an intimate friend.

(Of course it is understood that I am writing about European conditions, for it is in Europe that the manufacturer wishes to be represented, and it is such conditions that he will meet.)

To understand the reason for such a change it might be well to describe how such a company is usually organized in Europe. When the small dealer and his partner, the capitalist, resolve to start an incorporated company they wisely decide to elect as president some person carrying a high-sounding name; a man with the title of prince or marquis is eagerly sought. If they cannot find some one as high as this, a man with a lesser title will be elected. As the law makes it obligatory to have at least five members on the Board of Directors, sev-

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eral other people of titular rank are invited to become directors. The president and the other members of the board, of course, very rarely take any active part in the affairs of the company; they may, at the most, attend the regular annual meetings. Many such people, usually called "straw men," can be found who are perfectly willing to exchange their names for a certain percentage of shares and the dividends on these shares, to say nothing of the attendance fee for meetings at which they have not been present. Such persons are valuable as directors, moreover, because they are often directors in a number of other companies, and, therefore, they can easily arrange an exchange of orders at inflated prices between the various companies to which they belong.

The presence of these "straw men" on the board is often very useful for other reasons: Most of the men who thus capitalize tneir names fear to be compromised and will not accept such positions until they have made searching investigations and have found that the business is sound and on a good footing. An incorporated company of dealers, therefore, always makes a point of advertising the names of its directors. The active dealer himself continually speaks of his confreres and their great influence. Thus it is easily understood why our middleman is so willingly received by the officials of any factory where he may go to seek orders. Sometimes, it is true, the factory is afraid of reprisals, and again it may hope to receive orders in turn from another house which may have on its board some of the same directors.

We will suppose now that such an incorporated agency asks a manufacturer who has never sold his product abroad for the exclusive representation of his product in France. Because of the strong directorate the small manufacturer will feel no hesitancy in giving this exclusive right; and, indeed, if the agency should ask not only for exclusive territory in France but also in Belgium, Holland, Russia, or Japan, the manufacturer will be only too willing to grant the request. He would indeed be perfectly willing to sign a contract giving them the whole universe as territory. He would do this because he reasons in this manner: "At present I am selling nothing abroad. If I should establish my own agency I would entail enormous expense greatly beyond my means. This company asks nothing from me. I should not be required to spend any money to start the business, not even correspondence or advertising. I am risking nothing. Even if the company should sell only a few of my machines I will be so much to the good." And he will rush to agree as soon as the incorporated company asks him to do so.

There is, however, a very prominent reverse to this medal. The most favorable thing that could happen to such a manufacturer would be for the incorporated agency to devote some attention to the sale of his product, but this happens only occasionally, and even if it does the manufacturer will soon discover that he has little to do in dictating the sales conditions —the *agency dictates both terms and prices to him.* His share of the profit is not what he asks, but what the agency is willing to offer. If by any chance the sale of his products is seasonable, he must work through the dull season to get a stock on hand, and is squeezed by the need of working capital. If the incorporated company should advance money to him on his stock to meet his needs, he will find himself their unwilling tool, working desperately without profit to

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himself. It naturally follows that the small manufacturer soon becomes discouraged as he has to struggle against insurmountable obstacles, and unless inspired by great enthusiasm and great patience he ceases to struggle and allows his business to fail.

But more often such an agency makes no efforts whatever to sell the article of which it has the exclusive right. To appreciate how this may occur I will explain what usually happens. The agency, acting on a commission basis, desires to represent exclusively the largest possible number of countries for the longest possible time. If they, then, obtain the right to sell fifty or one hundred products it is evidently impossible for them to accomplish the sales of those goods in a short time. It becomes necessary for them to have a large organization and many branch houses, more than they can possibly do justice to. By acting in this manner the company has everything to gain and nothing whatever to lose. In its advertisements of products already well known all it has to do is to add another line for the new product. Its traveling salesmen make their rounds to sell the regular line of goods and can easily offer the new article. If they make some sales so much the better, if not, they have at least been able to keep some other salesman from offering this same article and a competing company debarred from handling the article. Such things may and do happen. It is no unusual thing for a manufacturer to reply to an agency who has asked for the privilege of handling his product in a given country, "I am very sorry but I cannot sign up with you. Such and such a concern is representing me, and although it has sold nothing, nevertheless, I must face the fact that I am tied up with them for a period of years."

These, then, are the conditions confronting the small manufacturer who contemplates the sale of his goods in foreign countries: He cannot afford to send his own agents to represent him; a small dealer can handle only a limited territory and is financially unable to bear the cost of introducing a new article; a commission house cannot be trusted to give time and attention to a small line in which the profits are little. Clearly there is an urgent need for a fourth method, and it is such a method which I shall hope to outline in my concluding chapter next month.

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EDITORIAL COMMENT

THERE are those who honestly believe that this Government is absolutely wrong in allowing the banks to consider even the granting of a huge loan or extension of credit to any one of the warring countries; conscientiously they cannot sanction it. Were the tables reversed, and were it Germany who was buying from this country, some of the same people would record themselves as opposed to the loan. The point involved is simply that of securities—waiving all considerations of sentiment. Such opposers to the loan reason, apparently, that the outcome of the war is uncertain, and, also, that its result can only mean the entire national extinction of the loser. It would seem, as Mr. Del Mar reasons, that Germany must lose, but such a result cannot be predicted with certainty; as to the second reason. it is perfectly obvious that none of the contending nations can be utterly destroyed nor their credit utterly destroyed. In an article entitled "Why the United States Must Finance the War" in the September issue of *The World's Work*, Mr. Theodore H. Price sums up the entire situation most admirably. We quote some of his more striking paragraphs:

For the Calendar year 1915, the excess of exports will not fall far short of $2,500,000,000. Obviously such a one-sided trade cannot keep up very long, but it may continue during the war. If it does how is the balance in our favor to be adjusted?

It is plain that Europe cannot send us gold in any such amount, and the supply of American securities held abroad is nearly exhausted.

The aggregate stock of gold held by European banks is only about $3,500,000,000, and if any substantial portion of this is surrendered the entire European credit fabric will topple. If those who are to ship the goods are not paid exports will cease and the resulting congestion will utterly check the distributive processes of both domestic and foreign trade in the United States, thereby precipitating a disastrous decline in prices.

The problem thus presented is the most important financial question that confronts this country today.

This article is written to make it clear that self-interest compels a popular acceptance of European securities, or promises to pay, in temporary settlement of the bill probably due the United States before the war is over.

As shipments to Germany and Austria are in very small amount the balance of trade in our favor with these countries will not amount to much, and, therefore, need not be taken into consideration.

As England is bearing the financial burden of the Allies it is probable that we shall be asked to accept her securities or promises to pay for the balance due us against the great volume of goods going to England, France, and Russia.

If we decline so to extend the necessary credit what will be the result?

Even to neutrals it must be evident that a collapse of the national credit of Great Britain would be followed by a worldwide deluge of bankruptcy for which there would be no Ararat even in the United States.

The magnitude of such a catastrophe is unthinkable. The national debts of Great Britain, Russia, and France are now approximately $30,250,000,000. The other debt of English cities and dependencies is about $10.000,000,000. The Governmental Banks of England, France, and Russia have deposits estimated at $2,337,720,000. The private banks hold a much larger sum.

Superimposed upon this credit structure, there is a mass of commercial and corporate obligations created in connection with the business and service of three Empires having an aggregate population of about 650,000,000 people.

The world's trade depends upon the fluidity of this stupendous volume of credit, and if it were congealed, as it would be by England's defeat, commerce would be practically at an end and all mankind would revert for a time to barter.

It is idle to suppose the United States can put itself outside the range of such a debacle should it occur, and self-interest therefore

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dictates that the people of this country should do everything in their power to avert it.

To that end it is necessary that through the various trade and investment channels America should absorb a sufficient amount of English obligations to offset the net balance due on merchandise account.

Capital is, however, proverbially timid, and at times requires an insurance against the impossible before it can be induced to take risks that are negligible.

It is just as well, therefore, to inquire deliberately whether there is any serious risk of loss in buying a 4½ per cent obligation of the British Government in the face of existing conditions.

The England of today has required a thousand years in the making and cannot be destroyed in a night.

Even if she has reached her climacteric, England's decline will be punctuated by long periods of prosperity when the hope of recovered greatness will find expression in commercial and financial expansion.

Forty-five years ago France lost Alsace and Lorraine and paid an indemnity of a billion dollars, yet she is today invincible.

The processes of national disintegration are so slow that they are not discernible except to the eye of the historian, and this fact gives to governmental obligations an element of value that is very important.

There is always a market for them. They can always be sold at a price, and the changes in their value are likely to be exceedingly deliberate.

Taking this into consideration, is there any security in the whole list of American investments paying 4½ per cent that is less hazardous than an obligation of the English Government?

But whatever the risks of the venture we are practically forced to accept them, for we must export to prevent depression. We cannot export unless we are paid. Our customers cannot pay us unless we lend them the money. Consequently we must lend them the money.

What folly it would be for America, who is the chief and almost the only beneficiary of Europe's military necessity, to hesitate ungraciously in giving our foreign customers the credit that we shall ultimately be compelled to grant, because if we refuse it we will destroy ourselves!

Along the same lines a prominent editorial in *The Evening Sun*, New York, states:

We must sell to the only nations that can buy from us in great bulk or we must face stagnation and hard times.

But if we are to sell with any advantage we must be paid. There are three methods of payment: in kind, in cash and in the manipulation of credit.

The writer then shows how the present condition of European industries makes either of the two first methods impossible. He goes on to say:

The two other means breaking down, therefore, recourse is had to the third method, a readjustment of the credit conditions of the nations which are parties to the present trade situation. The idea is that Europe shall pay us—that is, our farmers and our manufacturers—with money which is already in the United States. It is our money today. The loan negotiation means that it shall be their money tomorrow through purchase from its present holders, the banks of America, upon the usual, or perhaps upon very unusual terms. The European financial authorities, represented here now by official emissaries, offer to buy our money from us by the pledge of the credit of their nations and perhaps supplementary guarantees, and a heavy rate of interest, probably 5 per cent per annum. The scheme is that Europe should buy our money from our bankers in order to pay it again to our farmers, manufacturers and traders, and that they should pay a big price for their bargain.

This is all there is to the great loan project. It is obviously not only a benefit—a double benefit—but even a necessity to ourselves. We do not deny its importance to the Allies. But we insist upon its advantage to our own country. This is why we denounce as hypocritical and anti-American the agitation which has been started to hinder and embarrass the operation. They must know full well that they are fighting against the good of this country by opposing it. They are trying to render the continuance of our export trade impossible.

MR. LUNDGREN had an excellent opportunity in the first pages of this issue to make a strong plea for increased appropriations for extending the activities of the Forest Service, that he did not might be taken as due to his own modesty in recommending extensions in a branch of the service in which he is employed; more probably, however, he reasoned that his compilation of facts and figures would impress upon his readers the need for extensions of the work. Unquestionably this is one phase of governmental activities which deserves nothing but the heartiest support.

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INDUSTRIAL ENERGY AS A MILITARY WEAPON

EFFICIENT ORGANIZATION MORE IMPORTANT THAN PLANTS AND MATERIALS

J. R. Finlay—Bulletin, Mining and Metallurgical Society of America

AT the beginning of the war I had believed that industrial energy would be the decisive factor in determining the outcome and that this energy might be fairly measured by the use and production of coal and steel. After ten months of war it looks as if this idea was approximately correct. It is now evident that the Continental Allies are no match for Germany in the production of equipment and munitions and it is probable that even including England the combination is deficient in the capacity for organizing and for utilizing equipment.

The buying of supplies is a comparatively insignificant part of the problem. For an example, suppose the plants of the U. S. Steel Corporation to be set down in Russia without the organization itself, what use could Russia make of them?

I do not imply in this statement that the individual Russian as workman or as man is inferior to the American; each of the great nations and races of mankind can furnish human material to compete on equal terms with that of any other nation. But the operation of plants like those of the Steel Corporation demands specialized labor, skilled control, experience in marketing; and it demands an environment equally highly organized and efficient, which means the industrial organization and development of the nation, requiring at the least two generations to bring it about.

At present there are only three nations in which mechanical energy is widespread, the United States, the British Empire and Germany. Industry has been developed in other countries but these three are so far ahead of the others as to form a separate class. They produce about 90 per cent of the coal of the world and operate 90 per cent of its machinery. It is a remarkable fact—although it may be an accident—that all of these nations are predominantly Teutonic.

It happens that one of these nations is the most highly developed military nation in the world. The other two, while developed industrially quite as high, are about the least military nations in the world. In my judgment, the unmilitariness of England and the United States is due to one cause only, namely their isolation from enemies capable of easily attacking them. If these nations felt compelled to, they could develop enormous military powers, but from our available sources of reasoning, we may suppose that this development would take a long time and could be accomplished only by a thor-

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ough political and social organization on terms of military efficiency.

Let us compare the industrial development of Russia, Germany and the United States: In 1911 Russia from 255 iron and steel plants produced a little less than 7 million tons of pig iron and ready iron, about 25 tons per man. The U. S. Steel Corporation in 1910 produced about 22½ million tons, about 146 tons per man. Comparing United States pig-iron output in 1909 with that of Germany in 1910, the figures are probably 8·4 and 37 tons per man respectively.

Turning to fuels, the consumption of a nation may be taken as a better criterion of its industrial status than its production. The consumption of the Continental Allies taking 1 ton of petroleum as equal to 1½ tons of coal, was 135 million tons in 1912; the consumption of the British Isles and the English Colonies was about 252 million, a total of 387 million, as against a total production of 473 million. The consumption of Germany and Austria-Hungary was about 322 million, their production 340 million. Using these figures for an estimate of the changes that have taken place since the war began, there has been added to the Teutonic production, 25 million tons from Belgium, 27 from northern France, 6 from western Poland and 1 from Turkey, increasing the total to 381 million tons. Correspondingly the Continental Allies had their production decreased by 37 million; the figures for the British Empire remained about the same. Hence from a position before the war involving manufacturing energy about four-fifths that of the Allies, excluding Italy, the Teutonic group has advanced to a clear superiority over the entire combination including Italy.

How is it in the case of iron? Before the war Germany had a production of about 20 million tons to which she has added about 6 million from Belgium and France and some from Poland, a total between 26 and 27 million. The Allies from a total production of a little less than 20 million have decreased to 14 million, even including Italy. Thus Germany has advanced from a position of equality to a two-to-one superiority.

In the occupation of Northern France and Belgium, the Germans took away from the Allies territory consuming 50 million tons of coal and producing 6 million tons of pig iron per year. This iron production is equal to two-thirds the entire production of Great Britain and the plants lost were probably better suited to furnishing military supplies than the plants of the British Isles. This suggests strongly the nature of the "military necessity" of the invasion of Belgium.

In the consumption of fuels, the United States is easily the foremost nation, consuming on an average over 5 tons per capita per year. England, Belgium and Germany come next and stand about on the same level with a figure of 4 tons. Correspondingly, the industrial output per man in this country is higher than in any other.

Russia, from the point of view of fuel consumption, seems to be in about the same stage of development as was the United States in 1850, wood being largely used, even for locomotives, and the consumption of mineral fuel being about ¼ ton per capita.

France consumes about 1.6 tons per capita which would indicate an advance to about the stage of this country in 1875. Certain specialized industries are as highly developed in France as in this country but a greater proportion of the people work on farms and in small shops and thus more with their hands and less with machinery.

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The whole population within the German lines excluding Turkey is about 135 million; Turkey would add about 20 million. The coal consumption of these people is about 2.5 tons per capita, which would bring them equal in point of development to the United States in 1890. The white population of the Allies is about 285 million and the coal consumption per capita is 1.2 tons. This would put them equivalent to the United States in 1870.

Thus it appears clearly that measured by this criterion, the Germanic combination is about 20 years ahead of its opponents in the use of machinery. Furthermore the former draw their men and resources from a total area of about 1 million square miles, while the latter come many of them from the ends of the earth and dwell in an area of 10 to 15 million square miles.

It is now a popular cry that the Allies must be supported by the manufacturing resources of England and the United States. But manufacturing power is only half the problem. It seems likely that the organizing ability of Germany has attained a superiority over that of the Continental Allies in some proportion to her superiority in industrial activity.

We may illustrate the situation from our own country. Suppose another civil war in this country in which the states of Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York, Connecticut and New Jersey should be opposed to the rest of this country combined with Mexico, Canada, and South America for good measure. We should have a population of 40 million in a territory of 285,000 square miles opposed to a population of 150 million in an area of 15 million square miles. I believe that the group of states between New York and Chicago would win decisively. They produce 75 per cent of the coal and make 87 per cent of the iron of the country and have almost a monopoly of the engineering and manufacturing energy of the Western Hemisphere. Their territory contains almost all the plants available for manufacturing arms, munitions and special devices. In addition it contains the trained population, the trained leaders and the organizers. If we permit ourselves to imagine that this little group of states was organized under one efficient corporation which had the control of every citizen for the purpose of carrying on war, we should have in America something like the situation in Germany today.

We could well reject the idea that the New Yorker or the Pennsylvanian was in the least superior to the Texan or the Canadian, but that would not alter the fact that the superiority of this group of States in the production of munitions, the transportation of supplies, the organization of effective effort, and the ability to strike quickly would be very great indeed. If this group of States should make as its first move the occupation of West Virginia and Missouri, it would add to its superiority much as the Germans added to theirs by the occupation of Belgium and Poland.

Suppose Great Britain, as a further example, were to come to the aid of the other States and use her command of the seas to help them out with supplies and munitions of war, what would be the result? I do not think it would be decisive; I think the problem of conquering such a unit as the small group of States we are considering, would be insoluble. This group might not be able to make extensive conquests or to wrest the command of the seas from the English but it could meet any probable attack with such a wall of mechanical energy as to render expectant conquerors sick with hopes deferred.

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THE CORPS GOING INTO ACTION

BELGIAN ARMORED-CAR CORPS

EFFICIENT ORGANIZATION INCLUDES TWENTY AUTOMOBILES, CYCLISTS AND MOTOR CYCLISTS

W. F. Bradley—The Automobile

BELGIUM at the present time has the most carefully developed and the most efficient fighting automobile corps to be found in Europe. The best use of the armored automobile is not as an individual machine attached to infantry or cavalry units but in a self-contained, homogeneous corps capable of carrying out operations on an important scale.

Such a corps, as it exists in the Belgian army, comprises ten fighting cars, three officers' observation cars, one workshop car, two ammunition cars, three supply cars, one ambulance car, 100 cyclists and 12 motor cyclists. The corps is divided into two sections, each containing half the armored, ammunition, and supply cars and half the cyclists and motor cyclists, with one observation car each. The other observation car is used by the corps commander, and the ambulance and repair car are in common. The car crews comprise about 100 men, the total force of men and officers being over 200. The men are picked with great care, machinists, drivers, gunners, etc., being experts in their lines; many of the cyclists are professional road racers.

The design of the cars was carried out jointly by automobile engineers and artillery experts. Two makes of car are used, most of them are 20-horsepower Mors with Knight motors and the rest 18-horsepower Peugeots with four-cylinder poppet-valve motors. Speed and carrying capacity are about the same for the two makes. Wire wheels are used throughout, and are fitted with tires 880 by 120 millimeters; only one design of tire and wheel is used. The armored cars have twin wheels at the rear.

The Mors armored cars have a single compartment built of 5-millimeter steel plate with a partial, hinged roof over the driver. The men climb in over the sides, there being no doors. The two guns are mounted on a steel platform at the rear and will swing to fire in any direction. The machine gun, which takes a rifle cartridge, is normally mounted above the 40-milli-

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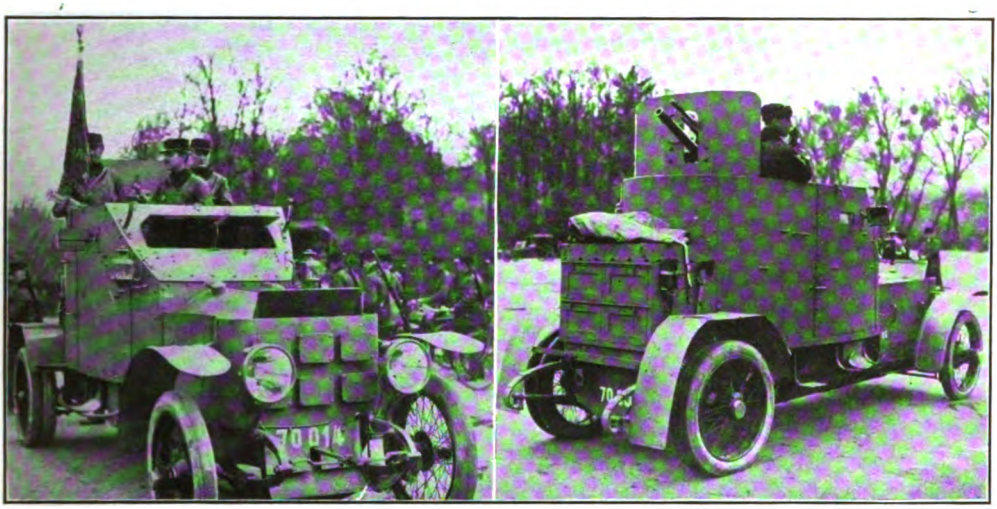

TWO VIEWS OF A FIGHTING CAR

meter cannon, but it can be unshipped and fired from the side in one direction while the cannon fires in another.

The driver has an eyehole in front and observation slits on the side, one of which, by means of a mirror, gives a view of the rear. There are two sets of clutch and brake pedals, and the central switch being centrally located, the reserve driver can stop the car, if the driver is shot.

The motor is protected by steel plates on front and side, the top being unprotected. There are six rectangular openings in the front with steel plates about an inch and a half in front of each opening; these with a wind scoop at the top and bottom of the radiator guard and two ventilator cowls in the top of the hood afford ample cooling. Oil, gasoline, spares and tools are carried in various places. The ordinary lighting is had by an electric system but an emergency gasoline outfit is also carried.

The observation car is also armor plated for the most part. It is divided into three compartments. In the first are the driver and his assistant, protected about as in the fighting car. The second small compartment, also armor plated, will just hold two men; it is equipped with a conning tower having several hinged flaps for sides so as to cover any opening not in use; the commanding officer and his lieutenant direct observations from this tower; they use a periscope and have maps and compass at hand. The rear compartment is unarmored and may be used to carry four men or the officers' kits.

The repair car has a van-type body, opening to the rear; its equipment comprises a pedal-operated drilling machine, a forge, a heavy vise, an anvil, complete sets of taps and dies and of hand tools. A stout workbench folds up against one side when not in service and the tool chests are strong lockers which may be taken out of the car when it is in use.

There are no special features about the ammunition vans. The supply cars are interesting; the van bodies are divided internally into sections to receive the 6-gallon cylindrical cans in which the reserve gasoline is carried. They also carry special lubricating-oil cans and have grooves for tires. Along the lower portion of two sides are lockers, six to a side, with outward-opening doors. These have separate locks, and also catches to

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operate if the attendant fails to lock them. They contain various small parts, systematically stored and easily accessible. The storekeeper keeps a running inventory of the parts on hand, so that he does not have to go through the lockers to know what stock he has at any time.

An armored corps in action is a thrilling sight. Suppose, for example, that a village held by the enemy has to be attacked. First the cyclists are sent forward to draw the enemy's fire, to ascertain his strength and to examine the condition of the roads. In this operation the large cars are concealed at the rear and the motor cycles are used to carry back to the commander the information obtained. When an attack is decided upon, the corps may be divided into its two parts, each with instructions to dash through the village by a different route. The dash will generally require the use of the quick-firing guns chiefly, although if entrenchments are encountered, the cannon may be employed to attack them. A staggered formation is usually employed for the dash, one car being on one side of the road and the one following, perhaps 50 yards to the rear, being on the other side of the road, and thus for the entire number. An infantry force cannot stand before a raid of this character unless in a village fortified especially to resist attack.

In trench warfare, relatively little use can be made of armored cars. In pursuit or in retreat, however, they are invaluable. In the case of a retreat, for example, they can be used to hold a position until overwhelming forces are brought up and can then get away free because of their mobility and speed. On the other hand, in pursuing a retreating enemy, they can harass him seriously by dashing into an attack and retreating again before they get into difficulties.

ARMORED CAR ON THE ROAD. THE OCCUPANTS CLIMB IN OVER THE SIDES

RECONNOITERING. NOTE BACK-AXLE ARRANGEMENT

It is a curious fact that the development of the application of the automobile in warfare was far behind its development for industrial purposes at the time the war broke out. In eight months after the war began more progress was made in this direction than for eight years preceding August 1, 1914, and as a result prejudice was scattered to the winds and practical knowledge gained.

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AERIAL SCOUTING

ADVANTAGES AND LIMITATIONS OF AEROPLANES AND DIRIGIBLES

Major H. Bannerman-Phillips—Transactions, North-East Coast Institution of Engineers and Shipbuilders

OVERHEAD reconnaissance, previous to the present war, had met with considerable success in Italy's campaign in Tripoli, in the Turko-Balkan campaign and in army manœuvres. The results obtained led enthusiastic supporters of aerial scouting to predict the complete supplanting of the cavalry for reconnaissance work, by aeroplanes, dirigibles and balloons. This is not likely to be the case; for certain kinds of work and under certain conditions, cavalry must be used; but the importance of the aerial service has grown tremendously and in many classes of work it is superior to the cavalry and its allied branches. Future development will be along the lines of co-operation of the two methods.

Kites, tethered balloons, aeroplanes and dirigibles are all employed for observation purposes, but the last two types of aerial apparatus are far more useful, from the fact that they permit horizontal motion and consequently a greater radius of action. The seaplane, capable of traveling on the water may be distinguished as a fifth class.

Military information is of three classes, strategical, tactical and protective. The first is concerned with the nature of the country and the disposition of the enemy before he advances; the second with his preparations for actual fighting after he is within striking distance; the third with the attempts of the enemy to attack or harass. In obtaining such information there are used: Spies, prisoners, local inhabitants, intercepted messages, newspapers and the services of certain branches of the army, chiefly the cavalry, but including cyclists, motor-cyclists, homing pigeons, and the signal corps. These are the rivals of aerial craft for the securing of information.

Cavalry scouting is largely combined with fighting, in the nature of screening, of overcoming the corresponding branch of the enemy, and of feeling out positions. Cavalry is so exceedingly useful for such work and for raiding, that it is politic to spare them from mere reconnaissance as far as possible. Cavalry is difficult and expensive to obtain, maintain and train. Hence from the point of view of economy alone, aerial scouting is welcome. Cavalry scouting suffers the disadvantage of being able to report information, only by slow methods, except that wireless outfits may be used to some extent.

Cyclists are of great service for reporting when the nature of the country permits their use. They are reasonably fast, are silent, and are able to transmit messages satisfactorily. For the same purpose motor cars and motor cycles are still more valuable, when the noise of their operation is no objection; near the enemy they are open to detection. Homing pigeons for sending back messages are perfectly practicable, being quick, reasonably safe and able to cover long distances.

Of the points about which information is demanded from the reconnaissance service, the most important are

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as follows: The positions and movements of the enemy; roads and tracks, with their condition as regards their use for traffic; rivers and their crossings, such as bridges and ferries; railways and equipment, with tunnels and sidings; buildings for attack, defence and occupation; defiles and passes; positions of guns, especially when concealed; entrenchments; woods; previously prepared gun platforms; defensive positions for occupation; camping grounds, water supply, food supply and transport facilities.

In securing information about the points listed, the aeroplane observer has first of all the great advantage of obtaining a bird's-eye view; in addition, he has a wide range of vision and a radius of flight of 70 to 80 miles. As compared with the cavalry he can obtain the information covering a wide territory in much less time and far more completely. He delivers his news while it is fresh and useful; if unable to land directly at headquarters he will be provided with motor or other means of rapid communication from his landing place; wireless equipment for aeroplanes has not yet been well tested and is subject to interference by the noise of the motor and propeller.

However the aeroplane scout works under certain inherent disadvantages. In the first place he is bound to be observable when observing; even if not seen at once the noise of his motor will disclose him. The enemy knowing of his presence can act accordingly; since aeroplane observation cannot be carried on continuously, the enemy may purposely change its arrangements while the information obtained by the aeroplane is being reported; aviators have been successfully duped thus in manœuvres, although with a strong corps, successive observers may be sent out and thus keep always in touch with changes. Again, the aeroplane scout sees everything in plan, with little relief of surface; he must travel at a high speed, and at low elevations everything passes rapidly before his eyes, while at high elevations objects are dimmed by distance. To be safe from rifle and artillery fire, he must keep above 4,500 feet, considerable elevation also being necesary in order that he may glide home or to a safe landing, in case of engine troubles. Frequently scouts must and do fly low in order to get accurate information, but once the information is obtained, they should return in the safest way possible in order that the information may not be lost with them. Although the percentage of casualties among military aviators is not high, nevertheless machines are frequently hit and great caution is always required.

The identification of aeroplanes is difficult and this probably tends to make their use somewhat safer, since fire may be withheld from fear of hitting a machine of one's own side. To overcome this difficulty, it has been proposed to use distinctive colors for painting, but above 2,000 feet, colors on an aeroplane cannot be distinguished and may even appear like some other color. The display of transparent colored streamers by a returning aeroplane has been suggested, but these would soon become known to the enemy and would be used for a disguise.

The state of the atmosphere is an important factor in determining at what height aeroplane reconnaissance can best be conducted; hazy weather makes it increasingly difficult for the eye to pierce the many layers of atmosphere involved in high flying. From over 3,000 feet it becomes difficult to distinguish objects.

Troops on the march can be estimated; artillery in action, transpor-

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tation operations, massed infantry in the open, are not difficult to make out. But an enemy under cover, halted during a march, or moving in extended order across a ploughed field, is hard to distinguish. To examine effectively fortifications, field works, trenches, fords, bridges, the air scout must descend to within rifle fire. Troops in towns are hard to estimate but the difficulty of concealing wagons and guns renders this somewhat easier. In misty weather dummy positions may deceive the aviator; but fogs and woods are the only really impenetrable covers. High winds and low temperatures make the work more difficult, the rocking of the craft in a gale rendering it especially hard to observe the ground. Railways at right angles to the line of flight are hard to see unless indicated by a moving train; railways parallel are easily made out and especially cuts and fills. Water and bridges stand out clearly. Troops apprised of the presence of a hostile aviator can conceal themselves by keeping motionless, removing any white in their dress, keeping their faces bent down, and by getting under even slight cover. Mounted troops in motion are often disclosed by the dust they make.

As for the dirigible, it has certain advantages over the aeroplane and certain defects. It can be used for night work, as an aeroplane cannot; it is even said that lights can be dropped from a great height to near the ground, for examining the country. The air ship can hover over a position, while the aeroplane must move; it can thus examine detail, listen for sounds and save fuel; it can navigate better by stars or compass; it has a wider radius of action; it affords a steady platform for close observation and puts less strain on the observers. It is, however, cumbrous, costly to build and maintain, requires an elaborate base for shelter and when near the ground it combines the unwieldiness of the mammoth with the fragility of an egg. Air-ship-destroying guns have been devised, some firing a special shell with a smoke fuse for tracing its flight. Splinters from a shell may interfere with the machinery of an airship and a shell bursting inside the envelope would be disastrous, but at the great heights and speeds attainable it is a difficult mark, and it is impracticable to bar the passage of airships except in the vicinity of large bodies of troops and important stations.

The aeroplane is handier, cheaper, and a poorer target than the air ship. Certain classes of work are especially suitable for aeroplanes: After a battle they are invaluable to the victor for ascertaining the direction of retreat of the beaten enemy, and to the beaten forces for finding available means of retreat; such work they can perform much more quickly and efficiently than cavalry and leave the latter free for pursuit or rear-guard work. Again, the aeroplane is pre-eminently useful as a platform from which to direct gun fire in the case of indirect firing. Its use for this purpose is one of the great advances in artillery progress. Finally they can be used for transfer of messages or persons when signaling is unavailable and when transportation over the ground is dangerous.

For protection against the enemy, the aeroplane occupants may use rifle, revolver, or automatic pistol. To obtain the best results, two occupants are desirable, a pilot and an observer, although single scouting has been successful. It is possible that future military campaigns will begin with a struggle for the mastery of the air, the victorious side thereafter being able to retain the supremacy and reap many advantages.

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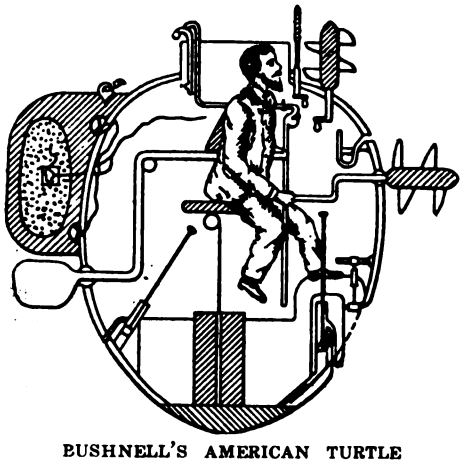
SOME EARLY SUBMARINES

INVENTIONS OF MANY YEARS AGO HAD VARYING DEGREES OF SUCCESS

*Simon Lake—International Marine Engineering**



BUSHNELL'S AMERICAN TURTLE

NAVIGATION in the depths of the sea has attracted the inventive genius of man for many years, but the first important progress was made at the time of the American Revolution, when Doctor Bushnell built a small one-man craft, called the *American Turtle.* This is illustrated herewith. The horizontal-axis propeller afforded motion either forward or back, the vertical axis propeller served to draw the boat under water after its buoyancy had been reduced by filling partly the water-ballast tanks. The latter could also be used alone to submerge. The submarine carried a mine on its back, which was attached to the hull of the British frigate, *Eagle,* when the latter was attacked; the mine, however, broke away again before its clockwork mechanism exploded it. This boat had not much speed but it possessed great inherent static stability, a feature often lacking in later models. That is to say, it would tend always to remain upright and not dive to the bottom.

The Robert Fulton submarine, also illustrated, had a different method of submerged control, this being effected by vertical and horizontal rudders at the stern. It also carried a collapsible mast on which a sail could be spread for surface navigation.

In 1850 a Bavarian named Bauer built the first German submarine. This was a flat-sided and flat-decked vessel and to control its position a weight was shifted forward to dive and aft to rise. It was built so light that it collapsed during a trial trip, Bauer, however, escaping through the hatch. It was dug up again out of Kiel harbor in 1887.

During the American Civil War, the Confederates built several small submarines called *Davids.* One of these, the *Hunley,* named after its designer, is of interest for the number of men it killed. The illustration shows its general shape. There were water-ballast compartments on each side and a diving rudder forward; eight men cranked the propeller shaft. Stability was lacking and twice the boat dived to the bottom and drowned her crew, on another occasion she drowned half of them in the same manner, and on a fourth, after sinking the *Housatonic* by means of a torpedo, she was swamped by the resulting wave and again drowned the entire crew; the total loss of life charged against her is 32.

Another Confederate submarine, called the *New Orleans,* shows rather good design as illustrated by the photograph. This craft was launched containing her crew of two negroes,

* First of a series of six to ten articles covering exhaustively the subject of submarines.

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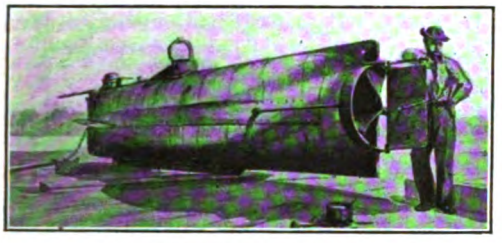


THE HUNLEY—FAMOUS MAN-KILLER

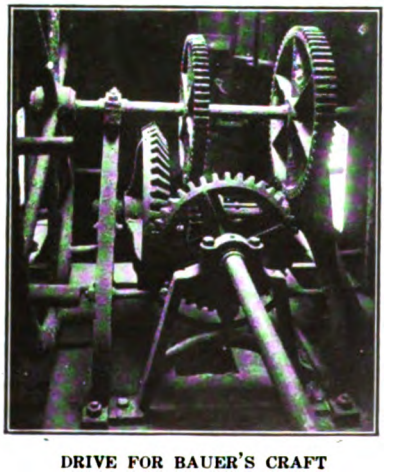
THE NEW ORLEANS

with the intention of having her dive from the ways and then rise again. She dived but did not rise. Many years later dredging operations uncovered her with two skeletons inside. Probably the ballasting was miscalculated.

Le Plongeur, shown in section, was brought out for the French navy in 1863 and 1864 and was in many ways the most completely equipped underwater craft of the Nineteenth Century. She was about 140 feet long, 10 feet depth and 20 feet beam, driven by 80-horsepower compressed air engines, with air-tank capacity said to exceed 5000 cubic feet. For submergence she had water-ballast tanks, and cylinders which could be forced out through stuffing boxes, for fine adjustment of displacement. While this control is ideal theoretically, in practice there are many disturbing features. Strata of different density exist in the water off river mouths; a slight inclination tends to send the water to one end of the tank; the movement of the crew disturbs the balance. Consequently perfect equilibrium is hard to maintain. Thus with *Le Plongeur* there was a constant tendency to dive to the bottom, rebound and broach to the surface. A novel feature was an escape boat bolted to her top and connected by a double hatch, into which the crew could enter in case of accident and detach themselves so as to ascend to the surface.

Returning to this country, the *Intelligent Whale* was the captivating title of a submarine completed in 1866 by O. S. Halstead of Newark. Mr. Halstead made a contract to sell this to the U. S. Government but died before the completion of the contract although he had received $12,250 on the $50,000 purchase price. His heirs got into disputes and the boat lay neglected for many years until re-

BAUER'S GERMAN SUBMARINE



DRIVE FOR BAUER'S CRAFT

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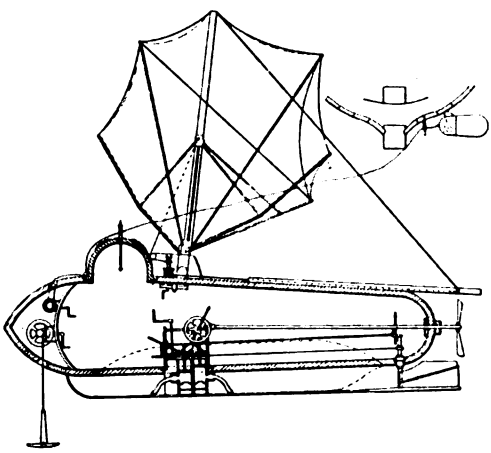
cently she was erected as an exhibit in the Brooklyn Navy Yard. This vessel was designed to be operated also as a diving bell, a trap door in the bottom being opened after the boat was filled with compressed air. Her design shows stability; horizontal and vertical rudders were provided for control.



FULTON'S SUBMARINE

The *Fenian Ram* was brought out by J. P. Holland in 1876. She was 30 feet long and 6 feet in diameter, and used vertical and horizontal rudders for submerged navigation. A gun to fire a shell by air under water was a novel feature. The illustration shows her general design. It appears that there were to be a number of these built and carried to England in underwater, outside-opening compartments of an innocent-appearing "mother ship." Then in some English harbor where there were a number of British war vessels, the submarines were to be released and sink as many of the British boats as possible, escaping in the confusion and consternation following the mysterious attack.

G. W. Garrett of Liverpool built a small boat in 1878 in which equilibrium was maintained by taking water into a cylinder and forcing it out by a piston. In a later vessel, the *Resurgam*, diving rudders were used. In this craft a large steam boiler was employed to store considerable heat and afford power for several miles' run after the fires were extinguished. This vessel was lost during her experimental trials.

Mr. Nordenfeldt became interested in this and improved it and built vessels for Greece, Turkey and Russia. The first boat, shown in the illustration, was 64 feet long, 9 feet beam and 60 tons displacement. Two downhaul screws in sponsons on each side of the vessel, operated by bevel gears, were to be used to submerge her, there being always a reserve of buoyancy. The propellers were to run all the time she was under water. Level keel was to be maintained by horizontal rudders at the bow. This principle of submergence is excellent and it would seem as if the abandonment of the idea was due to failure to carry out the details of design.

It is stated that the heat from the reserve in the reservoirs was so great as to make the boats almost uninhabitable for the crews and that it is doubtful whether any of the boats operated after delivery. They probably also lacked longitudinal stability and were difficult to keep horizontal. They were purposely made sensitive in order that the horizontal rudder might easily keep them horizontal. Means were provided for discharging under water the smoke from the fires and apparently in these boats torpedo tubes were incorporated in the hulls for the first time.

In 1887 Lieut. Isaac Peral built a vessel driven from electric accumulators, and operated by the usual vertical and horizontal rudders. The propulsion system worked well but the submerged control was poor.

Mr. Goubet built several boats between 1885 and 1890, of which one is illustrated herewith. The propeller worked on a universal joint so that the direction of thrust could be

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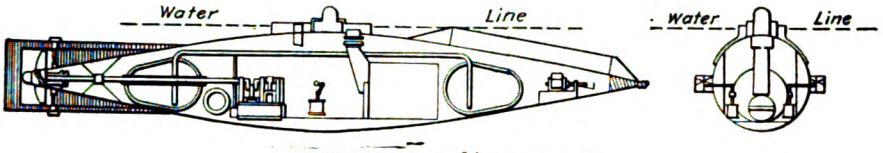
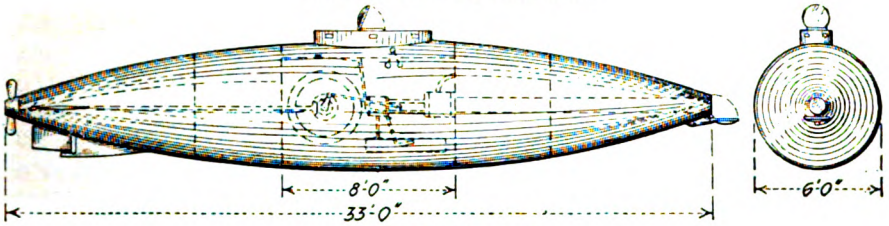
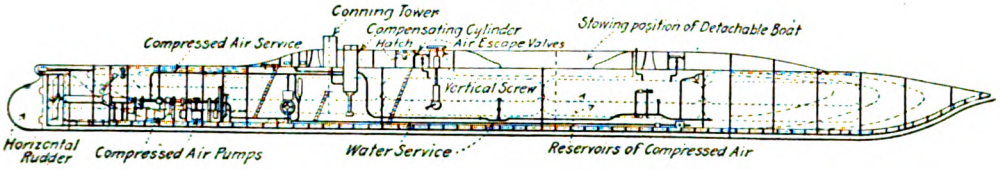


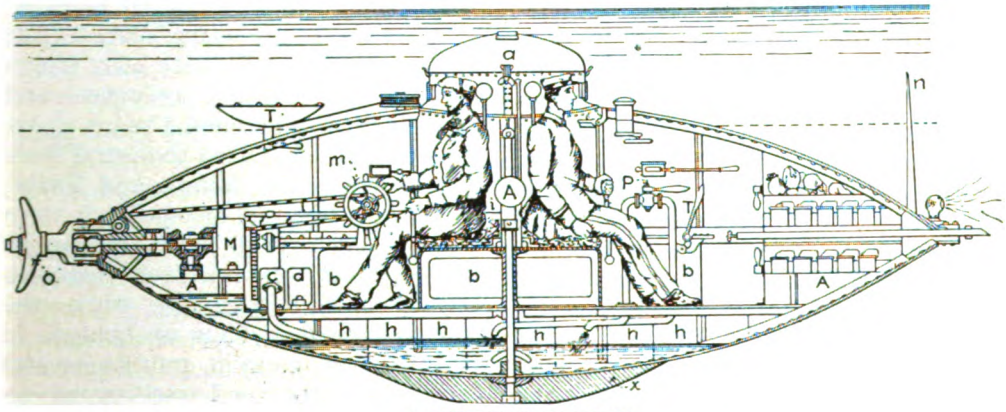
NORDENFELDT 64-FOOT BOAT



THE FENIAN RAM



LE PLONGEUR—AN EARLY FRENCH DESIGN



A GOUBET SUBMARINE

changed through any angle to drive the boat under water or to bring her to the surface; this took the place of the usual two rudders. In the illustration *A* represents the trimming-tank system, *a* the conning tower, *b* the compressed-air reservoir, *c* and *d* the pumps, *h h* water-ballast tanks, *i* electric accumulators, *m* wheel for moving propellers to port or starboard, *M* electric motor, *P* water-ballast control, *T* torpedo, *O* propeller, *X* safety weight and *n* submerging batten.

Prof. Josiah L. Tuck in 1885 built his *Peacemaker* which generated steam for submerged work by means of a caustic-soda boiler. In 1886 a Mr. Waddington of England brought out a small electric-accumulator boat with down-haul screws in vertical tubes and with side rudders.

The George H. Baker craft of 1882 was egg-shaped and used bevel-gear-driven side propellers for submerged running. These could be inclined to any angle to give a downward or upward thrust.

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FRENCH RAILROADS AND THE BATTLE OF THE MARNE

GREAT IMPORTANCE OF TRAIN TRAFFIC IN REGROUPING FIGHTING LINES, RETIRING THE WOUNDED AND CARING FOR REFUGEES

Walter S. Hiatt—Railway Age Gazette

NEVER in the history of railroading have men worked under operating conditions like those existing in France during late August and early September of 1914, when the territory to the northeast of Paris became the scene of one of the most gigantic battles of the war and every nerve was strained to get troops to the points where they were required. The seventeen railroads of the German Government,* all built with an eye to military purposes, have done great service in the war, but they have not been tried as yet by the fire that proved the French roads.

The work of the French railroads in connection with the battle of the Marne must forever prove a monument to the French railroad men. The fall of Charleroi was the beginning of that battle. On August 17 the minister of war had thanked the several roads for their part in the preliminary work of concentration. The seven armies of France had just finished concentrating and between August 12 and 20 the Northern, Western and Orleans roads had brought the English army from Boulogne, Nantes and Saint-Nazaire to Mons, handling 420 trains often at six-minute intervals. The railways were settling down to the steady transportation of munitions and supplies to the front and of the wounded to Rheims and Chalons. The vast stores of the armies were renewed each day by 42 trains set aside for the purpose. The Paris-Lyons-Mediterranean had brought its 60,000 troops from Africa to Charleroi. Then the Bavarian army drove the French back to the River Meuse and on August 22, the Battle of Charleroi began and ended on the 26th, in a French defeat.

During the battle, the roads were ordered to make ready to save as many men as they could. Meanwhile all lines in the north were busy transporting the Belgian refugees and those from the invaded French provinces; several hundred thousand were carried to Calais, Havre and Paris; and 2,700 Belgian locomotives were run out on French rails and saved. On August 23, the line from Sedan to Lerouville was open and while the troops burned or blew up bridges in their retreat, cannon, munitions and even the stored food were saved on trains. The trains were used for redistribution to the points along the Marne indicated for each corps and on some days 170 trains were employed in the retreat.

Hundreds of Eastern, Western and Northern trains were rushed to pick up all the troops possible in the Argonne region and swing them over to form a new army against Von Kluck behind Lille and Arras. The biggest job, however, was to carry an army from along the Meuse to block the passage to Paris. This army of three corps was supposed to be defending

* *c.f.* THE ENGINEERING MAGAZINE, April, 1915, p. 93.

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the Meuse south of Longwy. When that place fell on August 27, the 100,000 men were put aboard 180 waiting trains and carried over to Raincy where they played the chief role in the battle of the Marne. This lost army which the Germans failed to locate had made an entire change of front in a week. There it was joined by the few English rushed in the nick of time to Crecy-en-Brie and by the army of Paris brought out at the last minute by railroad, automobile and almost by foot.

The army of General Manoiry, which the railroads had assembled behind Rheims and the two armies at Nancy fell upon the Germans from three sides and won the most decisive battle of the war. Meanwhile the sleepless railroad men were scouring France for more troops and bringing them up to take the places of those fallen.

At the same time that the Germans were being turned back, their threatening approach decided the French government to leave Paris. Early in the morning of September 3, three special trains placed the president, the ministers and the secretaries in Bordeaux and later in the day other trains carried there $800,000,000 in gold belonging to the Bank of France, while still others carried away statues and paintings from the Louvre, the Luxembourg and other galleries.

Following and accompanying this, a panic-stricken population had to be taken care of. Refugees had to be removed from Paris by the hundred thousand; all the north of France was bent on flight. Women and children slept in the station waiting for a turn to board trains made up to include box, flat and cattle cars; 50,000 people were removed each day. To make a trip taking now three hours, three days were required; for the military trains had the right of way.

On the Northern and Eastern railroads, half the trackage was within the German lines and there were no more roundhouses and machine shops available. New ones were improvised; and right behind each engine a sort of wrecking car was hauled in which the crew ate and slept and in which spare crews were carried as well as repair material. With the Germans stopped, the work of the railroads kept up; reinforcements had to be brought to the River Aisne; food and ammunition had to be carried forward; refugees, German prisoners and wounded Allies had to be carried to the rear.

Meanwhile spare railroad men about the shops of Paris, Lyons and Orleans were put to work manufacturing wagon, caisson and cannon wheels, shells and even cannon parts. They helped hurry the heavy cannon from Creusot and Saint-Chamond to the Aisne and emptied arsenals of old mortars, fifty years old but of use once more for the siege warfare of the trenches.

To handle all this traffic trains were run ceaselessly. In five weeks one of the six railroad companies ran no less than 1,600 provision trains, part of the run being made over lines new to the crew.

One astonishing transportation feat was accomplished immediately after the battle of the Marne, when 52 ships arrived at Marseilles with 70,000 Indian troops on board. These with their immense quantities of baggage were discharged at their camp near Orleans in three days.

The mail service to the troops increased constantly and food had to be carried to the French inhabitants remaining in the invaded provinces. Gradually the roads put themselves in shape to resume ordinary traffic and now service in general proceeds as usual.

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PERISCOPES

SIMPLE AND ELABORATE FORMS WITH VARYING DEGREES OF CONVENIENCE

Ernest Coustet—La Nature

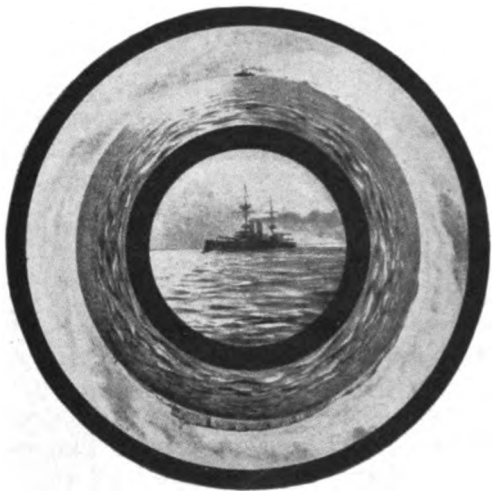

FIG. 1

THE simplest form of periscope is shown in Figure 2. A prism R_1 at the top of a 20-foot steel tube reflects the image through the objective O_1 with the focal plane E_1, and a second lens O_2 projects it to the plane E_2; it is then erected by the prism R_2 and examined by means of the eye-piece O_3 which has a magnification of 1.5. With a magnification equal to 1, theoretically, the objects appear smaller and farther off than they are in reality. This periscope has a field of 45 degrees, one-eighth of the horizon, but the tube may be turned to explore in all directions. Being monocular it does not permit distinguishing the various planes and also tires the eye. Attempts to make a binocular periscope have been given up, attributed to the fact that the diameter of the lenses being limited by the distance apart of the eyes, illumination is lost as stereoscopic vision is gained.

The combination periscope, Figures 3 and 4, lends itself to binocular use but is not stereoscopic. The image is projected upon a ground glass, as in a camera, and is thus easy to examine with both eyes, but it does not indicate the relative distances from the instrument of the objects. The upper part of the instrument is like that of the periscope just described. A real image formed upon the ground glass E_2 is reflected by the silvered inclined surface of the prism R_2, as in Figure 3; or there may be had a virtual image, Figure 4, which is examined with the eyepiece O_3. For this purpose the ground glass, eyepiece and prism are mounted on a drum with a horizontal axis so that they can be turned through 180 degrees, according to which kind of image is desired. The ground glass eliminates excessive fatigue on the part of the observer, but the illumination is faint, and the magnification of 1.5 is too little for distinguishing certain details.

To obtain magnification without losing clearness a normal objective and a telescopic objective may be combined, Figures 5 and 6, the telescopic composed of the converging lens L_1 and the diverging L_2. The two objectives are mounted to turn through 180 degrees so that either may be examined.

The periscopes described require 5 to 10 seconds for examining the entire horizon and are fatiguing in operation since rotation is difficult on account of the watertight joints and furthermore the observer must follow the eyepiece around. Revolving

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the top alone tips the image as the planes of the top and bottom prisms lose their parallel position; a quarter turn makes the horizon appear vertical, a half turn inverts it. To maintain the image upright, it is necessary to interpose another compensating prism. This is used in the panoramic periscope of Figure 7. The top of the fixed tube is a glass bell K containing

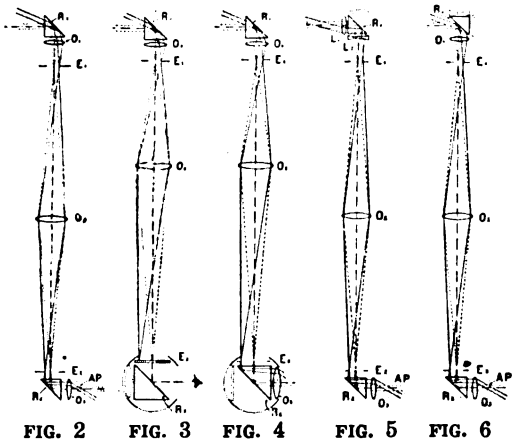

FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

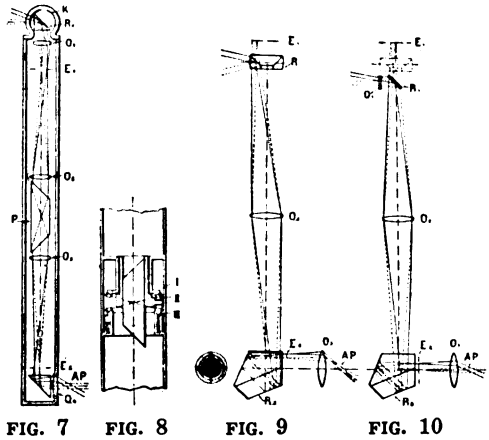

FIG. 7 FIG. 8 FIG. 9 FIG. 10

the rotating prism R_1. Two objectives O_1 and O_2 have the common focal plane E_1. The parallel rays from O_2 traverse the compensating prism P and are examined by the eyepiece and accessories as shown. The arrangement of the compensating prism is shown in Figure 8. A conical pinion III on the mounting of the prism, meshes with the racks I and II, I being attached to the tube on which the upper prism is mounted. The relation of the gearing is such that the compensating prism is rotated just one half the amount of the upper and this has the effect of keeping the image always erect.

To observe successively all points of the horizon it is necessary only to turn the inner tube by means of its handle; since it is mounted on ball bearings, it turns easily and does not tire the observer; furthermore, the latter looks always into a fixed glass and does not have to move.

Although a rapid survey is possible with this periscope, it does not give the effect of a single glance, and when a continuous observation of the entire horizon is necessary, the pilot ought not to have to change his field of vision and risk losing his sense of orientation. To obtain a simultaneous glance of the entire horizon the annular-image periscope of Figure 9 is available. At the top of the tube is an annular lens R with a spherical outer surface and an ellipsoidal, silvered interior surface. The entering rays are refracted and then reflected toward the base of the tube, and are focused by the objective O_2 into the plane E_2. The panoramic image formed is seen by means of the pentahedral prism R_2 and the eyepiece. While this image is comprehensive, it appears smaller and more distant than the object seen with the naked eye. Therefore the circle in the annular space is used for a somewhat magnified image by means of the divergent lens O_1 of Figure 10 and the reflector R_1. Figure 1 shows the resulting view, about 25 degrees of the horizon being reproduced on a large scale in the small circle. This magnified field can be revolved to include any part of the horizon, by turning the central periscope as it may be desired.

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MUNITION METALS

RESOURCES OF THE TWO SIDES IN THE WAR

H. C. H. Carpenter—Nature

THIS article is an attempt to compare briefly the resources of the Allies and of the Teutonic combination in respect to the metals which are essential for war purposes.

The most important metal is iron, the basis of the steel which is used in a multitude of ways. Both sides can show abundant resources of iron ore and of the plants necessary to produce the metal. The Teutonic deposits, however, would appear to be of lower grade from the fact that Germany makes 96 per cent of her steel in basic-lined furnaces and England only 36 per cent.

For shrapnel and high-explosive shell casings, openhearth steel is used, and to make this from pig iron requires the addition of manganese. Thus manganese is very important; it is used in the form of spiegeleisen or of ferro-manganese to deoxidize the steel and to leave a small percentage in the finished product. Manganese producers in the order of their importance are Russia, India and the United States. In 1913 Germany imported about 670,000 tons of high-grade ore, chiefly from Russia, six or seven times her domestic production including Austria-Hungary. It is unlikely, however, that the shutting off of outside supplies will hamper her. Manganese is wide-spread in nature and while many deposits remain unworked because more valuable ones are available, in times of stress these could furnish large quantities of lower-grade ores. Germany could thus supply herself, and her metallurgists could easily solve the problem of handling the poorer material; it seems probable also that she had accumulated stores previous to the outbreak of the war, and she may be able to discover substitutes.

Nickel is an indispensable constituent of gun and armor-plate steel, as well as of the modern bullet and armor-piercing projectile. It is doubtful whether any satisfactory substitute could be found. The Canadian mines produce about 85 per cent of the world's supply, most of it refined in the United States, some in South Wales; New Caledonia supplies the balance except a little from Norway. Fully 98.5 per cent was produced in Allied countries before the war.

Nickel ores occur in the Teutonic countries and could furnish some metal, but they would be inadequate for the needs of Germany even if she gets the 400 tons produced by Norway. For in the first half of 1913 she imported almost 7,000 tons of ore and 3,500 tons of metal, while her exports were only 2,409 tons of metal for the entire year.

Chromium is almost as important as nickel, being an essential constituent of armor plate and armor-piercing projectiles. Most of it has come from Rhodesia and New Caledonia, some from Russia and some from Greece and Asia Minor, the production of the last two countries having declined lately. It is likely, however, that Germany could obtain all she needed from Asia Minor even if Greece should join the Allies.

Copper is of prime importance in the manufacture of munitions of war. All shells are ringed with a copper band to expand into the rifling, thus stopping the passage of the gases and

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keeping the shell itself from contact with the gun barrel. Before the war, some zinc was used with the copper to lower the cost but with zinc selling higher than copper this is no longer necessary. Copper is also used in cartridge shells, in shell fuse-heads and in Admiralty gun-metal and high-tension hydraulic bronze.

Of the world's output, about a million tons, the United States produces over half, Germany and Austria-Hungary about 3 per cent. All the belligerent countries except Japan imported from the United States. The Allies have obtained copper at will since the war began, while their enemies have been in straits. The latter have probably received a good deal through neutral countries, but their own production being only about 10 per cent of their peace consumption, it is certain that the use of copper is being restricted to purposes for which it is essential. Reserves must be greatly depleted and all producing plants worked to their utmost capacity, while strong efforts are being made to develop substitutes.

The use of aluminum has received a great impetus from its suitability to the construction of air craft. It is also valuable as an explosive. "Ammonal" consists of ammonium nitrate and finely divided aluminum. It is a disruptive explosive not suitable for propulsion but excellent for filling explosive shells. The United States and Canada have produced about half of the world's supply, the rest coming from France, England and Switzerland. The latter is available for Germany and Germany herself has become a producer, but the Allies, especially in view of the bauxite deposits of France, are in a far stronger position.

The advance in the price of zinc, five-fold, has been one of the most spectacular events of the war. Germany has heretofore smelted large quantities, drawn largely from Australia, but there are available supplies within the Teutonic boundaries. Great Britain is experiencing a shortage, due to inadequate smelting works, and has to draw upon the United States for most of her supply. Zinc as a constituent of brass is used in cartridge cases, and also for galvanizing barbed wire.

As for lead, Germany is a large producer, while the Allies draw most of their supplies from the United States, Mexico and Spain. Lead is used for bullets, the shrapnel bullet being a lead-antimony alloy. Antimony has advanced in price as has zinc; the most of it comes from China.

Tin is used in bearing metals, various solders, tin plate and gun-metal. The ores come from the Straits Settlements and Bolivia chiefly. England has smelted a good deal. The Teutonic countries have heretofore relied upon imported ores for their supply and their domestic resources are very inadequate.

It appears then that of the ten leading munition metals, Germany and her allies can produce five without recourse to imports, namely, iron, manganese, chromium, zinc and lead. It is questionable whether they could supply themselves with nickel, copper, aluminum, tin and antimony from their domestic deposits. It is reasonably certain, however, that before the war, they had laid in large stocks of these metals or their ores and that a very long war indeed would be required to exhaust them, while in that event it is a safe conclusion that their metallurgists will have been employed in the discovery of substitutes for the metals likely to run low. The Allies need have no fear of a shortage in any direction except that zinc may be scarce for a while.

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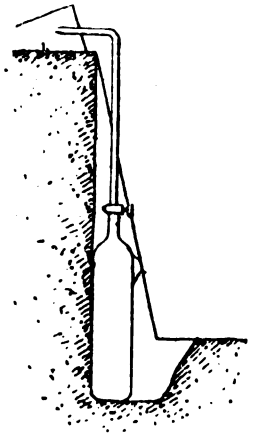
COMBATING POISONOUS GASES*

NATURE OF ASPHYXIANTS AND MEANS AVAILABLE AND EMPLOYED IN THE PRESENT WAR FOR RENDERING THEM INNOCUOUS

Pierre Pascal—Le Génie Civil

ASPHYXIATING gas used for trench warfare may be a two-edged sword. Its handling requires extreme care to prevent injury to the side employing it and at the same time conditions must be entirely favorable to render it at all successful against the enemy. Furthermore, ready means are available for combating it by the side attacked.



RECEPTACLE IN TRENCH

It would appear from the evidence available that the Germans have used for asphyxiating purposes chlorine for the most part, with some bromine, formaldehyde, nitrogen gases and sulphurous anhydride. Chlorine is chiefly to be feared, on account of being the predominant gas and on account of its extreme noxiousness; the effects of bromine are practically the same. Formaldehyde has the peculiar property of making the eyelids swell, which interferes with aiming the rifle. The reason for suspecting the use of nitrogen oxides is the yellow discoloration observed on the skin of some of the victims. Chlorine and bromine attack the tissues, particularly the tender mucous membrane of the mouth, throat and nose, which they destroy. They produce a hard cough, spitting of blood and finally asphyxiation by destruction of the breathing apparatus. Death may be immediate or it may be preceded by several days of extreme suffering.

There are four ways in which gases may be used against troops. One way is to kindle fires; by this means sulphur dioxide may be generated and also formaldehyde. The second method is to allow compressed gases to escape from receptacles in the trenches. Liquid chlorine is well adapted for this purpose and is plentiful in Germany, being a byproduct of the manufacture of soda from salt, and also of the manufacture of electrolytic hydrogen for filling balloons. A third method of launching gases against the enemy is by means of glass bottles filled with a liquified gas or a readily vaporizable liquid, and thrown by hand or by catapult. The fourth possible method is to use projectiles in the form of bombs, the confined gases being liberated by means of a time fuse or percussion cap; it does not appear, however, that the German long-range guns have been thus utilized.

The Germans seem to have adopted the first two methods, particularly the second. They confine the gases in cylinders about 10 inches in diameter and 4 to 4½ feet long, with a ¾-inch pipe 6 or 7 feet long attached to the top and bent at right angles as shown in the illustration; the whole apparatus weighs charged about 140

* *c.f.* THE ENGINEERING MAGAZINE, August, 1915; p. 739.

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pounds. The escape of the gas is controlled by a valve. These cylinders are set up in the trenches, as shown, with the nozzles turned toward the enemy, a few inches above the ground.

When the valve is turned the gas is projected and spreads over the ground because of its high density, several times that of air. If the ground slopes slightly toward the hostile trenches or if a light breeze blows in that direction the gas runs down and fills all the hollows in the ground like water. The cylinders are arranged in groups of three, four or more, spaced 75 to 100 feet according to the configuration of the ground. The emptied cylinders are sent to the rear for refilling.

Probably the receptacles contain at the same time both liquified chlorine and bromine, which is of course a liquid at ordinary temperatures. The bromine is practically as noxious as the chlorine and emits vapors which are brown-red in color. This is the color of the gas clouds which have been observed, although the peroxide of nitrogen has the same color. The bromine vapors are more dense than the chlorine. Bromine is easily obtained from the Stassfurt salt workings as a byproduct. The process of extracting it is simple and is rendered easier from the fact that it does not have to be pure for this purpose.

Apparently, the handling of the apparatus is not without danger; it is necessary to prevent premature opening or breaking of any of the cylinders, or glass bottles or bombs, either through inadvertence or from the fire of the enemy. The Germans have trained a special corps for the work, equipped like divers, and the other men in the trenches are furnished respirators, consisting of small bags of cotton wet with a salt solution, attached to the coat by a button when not in use.

The noxious effect of the gases has been felt over 2,000 yards back of the front trenches of the Allies and they can be smelled three miles from the point of discharge. A content of one in one thousand of chlorine in the air will cause immediate death. One in one hundred thousand makes air dangerous to breathe for any length of time and great inconvenience is caused by even more dilute mixtures. Knowing the required content of chlorine and the area and depth to be filled with the poisonous mixture it is easy to calculate the quantity required. The Germans have produced gas in such quantity as to form a cloud 40 feet high in places, maintained for over four hours along a front of five miles. A gas attack always signals its imminence by the appearance of the cloud in the daytime and by a whistling sound at night.

For the successful use of the gases, in addition to a favorable wind and one not so strong as to scatter the gas, it is necessary that its direction be assured for some time so that the gas may not be blown back, and also that the air be not too damp, in order that the gas may not be absorbed by the moisture. Even when conditions favor the use of gas there are abundant methods of combating it in a legitimate manner.

In the first place, the discharge of black-powder grenades in front of the threatened trench is a great assistance, the liberation of the black-powder fumes having the double effect of dissipating the gas by the violence of the explosion and of neutralizing it by a reaction in which potassium sulphate combines with the chlorine to form sulphur and potassium chloride.

A second protection consists of liberating in front of the trench at-

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tacked, some volatile alkali such as ammonia, which with chlorine forms nitrogen and hydrochlorate of ammonium; but the ammonia itself requires careful handling, since it is suffocating and caustic; ammonium hydrochlorate will form a dense, white, opaque cloud.

The best protection against the gases is to use a respirator in which cotton is saturated with a solution of hyposulphite of soda, a neutral and non-caustic alkali. This with chlorine forms common salt and tetrathionate of soda, unless the chlorine be in excess, when hydrochloric acid, sulphuric acid, sulphate of soda and sulphur are formed. The hydrochloric acid is itself an asphyxiating gas but not comparable with chlorine; furthermore it is more easily absorbed by water than is chlorine and is therefore taken up by the water of crystallization in the hyposulphite, by the hygroscopic water, and by the damp cotton itself. If it does get into the mouth its effect can be largely neutralized by swallowing; this forces it away from the back of the mouth and nose and brings it into contact with saliva, in which it dissolves and enters the stomach, an organ much more resistant than the lungs. Swallowing is a good protection against all the soluble asphyxiating gases, such as ammonia, sulphurous anhydride, and formaldehyde, and somewhat less efficacious against chlorine, bromine and the nitrogen oxides.

The addition of a little carbonate of soda to the solution on the cotton tends to neutralize the hydrochloric and sulphuric acids that may be formed. Lacking a respirator of the type described, protection against the gases may be had by simply placing over the mouth and nose a piece of wet linen. If water cannot be procured, urine is excellent for wetting the linen, since it contains organic material which reduces the chlorine, bromine and nitrous oxide, forming with chlorine, for example, carbonic acid, nitrogen and hydrochloric acid. All spongy, organic material when wet will retain great quantities of chlorine. Thus hay or straw chopped up and soaked for several hours could be made into a breastwork practically impenetrable by the gas or could be used in a respirator instead of the usual cotton.

To overcome the irritation of the nasal passages and throat after having breathed the gas, a solution of bicarbonate of soda or of Vichy salt, either gargled or snuffed up the nose and ejected through the mouth, is satisfactory. This serves to remove the tissues attacked and to neutralize the acids formed. The Germans use a hypodermic injection of atropine against asphyxiation.

The simple respirator has not proved wholly satisfactory and is being replaced by a hood, which goes over the head like a bag and is buttoned in between the vest and the shirt. It has a mica window opposite the eyes and the cloth of which it is made is soaked in a solution of hyposulphite and bicarbonate of soda together with glycerin, the latter to keep it moist. The hood does not interfere at all with breathing or moving when worn and when not in use is wrapped around the cap like a turban. It is efficacious against chlorine, bromine and the nitrogen vapors and to some extent against sulphurous anhydride.

If reprisals in kind were to be attempted, there are a number of other gases which would be available, such as hydrocyanic acid, arsine, carbon disulphide, hydrogen sulphide, and certain cacodylic compounds. It is likely, moreover, that if gas were used it would be one producing prompt anesthesia without pain.

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GERMAN COPPER RESERVES IN ELECTRIC CIRCUITS

GREAT WEIGHT OF METAL FOR WHICH IRON MAY BE SUBSTITUTED

F. Loppé—Le Génie Civil

IT is well known that among materials lacking in Germany, copper is the most important, inasmuch as it is essential for the manufacture of munitions of war. The Germans are employing extraordinary methods to procure it and it is rumored that an issue of securities recently put out by the city of Berlin for the purpose of taking over electric plants was to permit substituting iron for copper in the transmission wires. Whether this be true, it is not incredible and it is known that technicians and manufacturers have been experimenting in that direction. It is therefore interesting to make an approximate estimate of the copper which is thus tied up. By adopting certain approximate constants for voltage drops, etc., with both alternating and direct currents, and for different classes of service, a series of formulas can be deduced which will give the approximate number of pounds of copper required per kilowatt of power.

In this way it is found that for a primary high-tension distribution system, 5 kilograms are employed per kilowatt. For a secondary lighting circuit at 110 volts the weight is 20 kilograms and at 220 volts it is 5; since the former tension is the more common, the average is about 15. The total weight for both primary and secondary is therefore about 20 kilograms per kilowatt. For a power system the primary would take about the same weight, 5 kilograms, and the secondary about 2, a total of 7. For a tramway system the total would again be 20.

According to statistics, the German power plants in the spring of 1913 aggregated about 2,100,000 kilowatts, serving a rated consumption of 3,800,000 kilowatts, divided into 37 per cent for lighting, 52 per cent for power and heating and 11 per cent for tramways. Applying to the period from 1913 to the beginning of the war, the ratio of increase holding from 1909 to 1913, the power consumption in 1914 was 4,500,000 kilowatts.

There would therefore be required for lighting circuits 34,000 metric tons of copper and for power circuits 16,000. But since distribution systems are based on the power generated, this figure is probably high. According to railway statistics, tramways in Germany in 1911 consumed 201,704 kilowatts. Applying a factor of growth, this was probably 220,000 in 1914, requiring for wiring, 4,400 metric tons of copper. The total copper reserves of this kind would then be 54,400 metric tons.

The question of the replacement of this copper with iron is a difficult one. For overhead transmission, the increased section and weight would require an almost impossible reinforcement of the poles and insulators and for subterranean circuits the increased size and number of the conductors would be immensely troublesome.

For these reasons and for others, the figure arrived at can be considered only as a maximum, which would be reduced by an unknown amount when the attempt to draw on the reserve was made.

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RAPID-FIRE FIELD-GUN CARRIAGES

DEVELOPMENT OF DEVICES FOR ABSORBING THE SHOCK OF RECOIL

La Nature

RAPID firing depends upon maintaining the direction of aim of the gun undisturbed by the shock of recoil. To do this an absorbing brake or spring is interposed between the cannon proper and the carriage so that the former moves while the latter is fixed. In order to maintain the carriage fixed, recourse was had to the old trailing spade illustrated in Figure 1. This is designed so that when it has been once driven into the ground by the shock of the recoil, the flat portion *b* between the spade proper *a* and the sole *c* bears on the ground and is normal to the direction of stress; the ground between *a* and *c* is compressed and cannot be torn up.

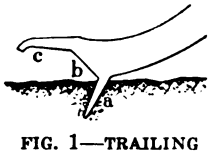

FIG. 1—TRAILING SPADE

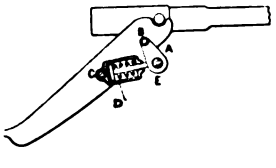

FIG. 2—CANET 75 GUN

A Russian colonel Engelhardt in 1876 designed the carriage shown in Figure 3, in which the shock was taken up by the rubber buffers *A* interposed between the stays *B* and the gun cheeks *C*. By this means the distance of recoil was reduced to a foot.

The Canet 75 gun of 1889, Figure 2, interposed the lever *A* and the spring-recuperator *D* between the gun cheeks and the axle, the system having the pivot points *B*, *C* and *E*. This carriage was fitted with wheel brakes but no trailing spade. The same engineer in his 1895 type of carriage employed two telescopic tubes to act as a hydro-pneumatic brake, Figure 4, the whole carriage moving except the plunger tube *A* which was fixed to the ground.

While the defects of these early devices are obvious they did reduce the recoil to a few inches, rendered it easier to recover the direction of aim and increased the rapidity of fire to five or six shots per minute. The first hydro-pneumatic brake and air recuperator were applied to the 120 Short and 155 Short models of 1890. This device later in 1897 assured the success of the French 75 gun.

A hydro-pneumatic brake consists of a steel pump barrel attached to the cannon, a bronze air-reservoir or recuperator, and a piston and piston-rod in the recuperator. The mechanism is shown in detail in Figure 5. The piston rod *A* is hollow, furnished with large openings *B* near the piston end; where the rod enters the reservoir, the longitudinal opening is closed by a valve; the end of the rod carries the nut *C*, the plug *D* and the spring *E*. A movable diaphragm *F*, with the head *G*, the nut *H*, the leather gasket *I* and the rubber gasket *J* separates the water reservoir from the air chamber; the initial pressure of the compressed air is 110 atmospheres. The pump barrel *K* recoils with the cannon, the relative movement of the piston *L* to the right forcing the liquid through the hollow rod and compressing the air. At the end of the recoil, the pressure of the air forces the liquid back into the pump barrel through the orifices *O* arranged about the valve, which is, however, forced strongly against its seat, and the cannon returns to its normal position. The function of the recuperator is to store part of the energy of the recoil for use in return-

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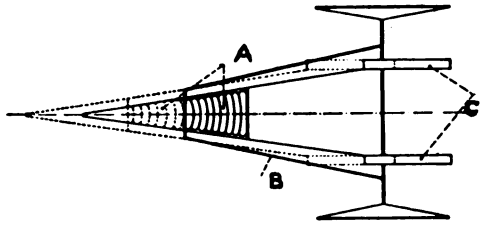

FIG. 3—ENGELHARDT CARRIAGE

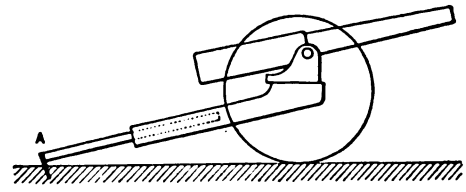

FIG. 4—CANET 1895 TYPE

ing the cannon to its first position, while the rest of the energy is transformed into heat in the hydraulic brake.

In applying the hydro-pneumatic control to mountain guns, the difficulty was encountered that at the high angles of fire demanded, the breech would be driven into the ground by the normal length of recoil, especially since low carriages were necessary in order to reduce weight. The arrangement of mounting shown in Figure 6 was finally devised. The carriage consists of two axle-plates *A* joined by trunions to the pieces *B*, themselves composed of two hinged parts, the degree of hinge motion controlled by the wedges *C*. This permits shortening or extending the carriage in manipulation. The braces *I* are attached to the hinging points. The angle of fire can be varied from 24 degrees to 35. The hydraulic brake and the double recuperator are carried on a frame *G*; the double recuperator consists of two telescopic springs, one on each side of the hydraulic cylinder. A rack under the cylinder provides means of fixing the recoiling parts in their firing position, by means of the bolt *D*.

In the firing position, the springs of the recuperator are compressed; on disengaging the bolt *D* by means of the firing lever *E*, the cannon is shot forward and the firing takes place automatically when the hammer is actuated by the firing bolt *F*. At the end of the recoil the cannon is stopped by the bolt which engages one of the teeth of the rack.

The momentum of the cannon as it is launched forward tears out of the ground the spade *H*.

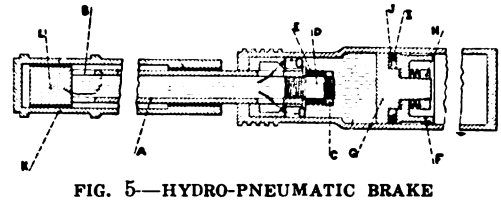

FIG. 5—HYDRO-PNEUMATIC BRAKE

The recuperators which we have been describing are pneumatic; most of the foreign artillery pieces, such as the German, Russian and Austrian, are equipped with recuperators employing a spring almost always helical and made of tungsten or silicon steel either round or square in cross-section. Usually two springs of different diameters are fitted one within the other and receive the stress of compression in parallel. Telescopic springs are also used.

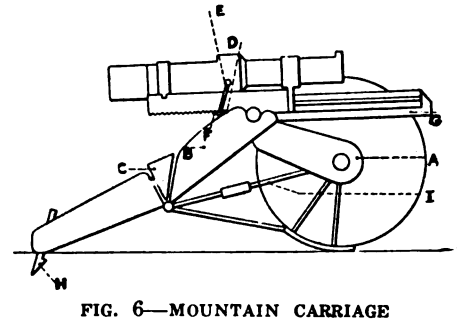

FIG. 6—MOUNTAIN CARRIAGE

The behavior of the 75 carriages in the present war is one of its most brilliant features; after many thousand shots their rigidity is uneffected. As the artillerymen say, "You can put a penny on the wheel and the shot won't budge it."

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SUBMARINE MINES

THEIR DESIGN AND THEIR MANNER OF FUNCTIONING

James Huber—Journal, American Society of Marine Draftsmen

SUBMARINE mines as used in warfare may be classified into ground, buoyant, floating, barrage and counter mines.

Ground mines are tied close to the bottom at harbor entrances and similar places, so that in general shipping will pass over them unharmed, and are held down by links containing explosive charges. When it is desired to explode one an electric circuit is closed and the charge of the explosive link ignited, breaking the link and allowing the mine to rise to a predetermined depth where it will be struck by the ship.

A buoyant mine is designed to float fixed near the surface and explode when struck. The simplest form involves a number of firing levers which are depressed when struck by a vessel and ignite a detonating charge; unfortunately these levers often are rendered inoperative by marine growths. The electro-mechanical type differs in that the firing pin completes an electrical firing circuit instead of causing direct detonation.

The hydrostatic type is arranged to explode when it receives a certain inclination because of contact with a ship. It involves a diaphragm which is acted upon by the pressure of the water to unlock the actuating mechanism. This actuating mechanism involves a heavy ball which oscillates in a concave bearing and is attached to a trigger by a chain from its lowest point. As the mine is tipped the ball swings and pulls the chain and the trigger detonates the charge. Two objections to this design develop. In the first place when there is a great range of tide, either the hydrostatic pressure at low tide may be too little to release the mechanism or the submergence will be too great for contact at high tide. In the second place, the nature of the contact with the vessel may be such as to cause the mine merely to spin and not to heel over sufficiently to pull the trigger. Furthermore, the diaphragm is exposed to marine growths which in time render it inoperative.

In the more modern and reliable type of mine, the pull of the anchor when the mine is struck is used to compress a firing spring, which then releases a striker and explodes the mine. Unless the mine is anchored, therefore, it cannot be exploded. Such a design of mine involves all the features essential for satisfactory operation. First, it is safe for handling, stowing and launching. Second, it is reliable and certain to explode. Third, it is arranged so that its depth of immersion is constant no matter what the depth of the water.

The modern mine consists of two steel hemispheres welded together to a sphere 2 or 3 feet in diameter, and carries from 100 to 250 pounds of guncotton, nitrogelatine or other high explosive. This charge is in a separate chamber and may easily be placed in the sphere or removed from it. The buoyancy of the mine ranges from 100 to 250 pounds. It is attached to a cast-iron or steel anchor, cylindrical, square or mushroom-shaped, weighing 500 to 750 pounds. This is arranged to carry the mine on its top for stowing or launching, and to run along launching rails by means of wheels or rollers on its bottom. A wire cable 300 to 600 feet long at-

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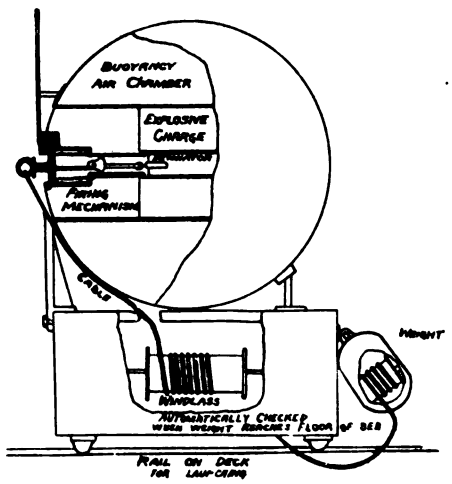
taches the mine to the anchor and is carried on a drum in the latter; a brake controls the speed with which the cable is paid out on launching. A cast-iron ball, the sounding ball, is attached by means of a wire rope, to a device in the anchor which can stop the rotation of the cable drum; this wire rope is wound on a cable in the sounding ball itself.

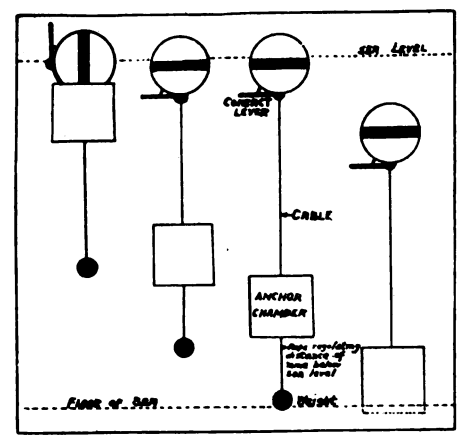
Launching is carried on from rails which end in a downward curve over the stern. The sounding ball is carried on an outside bracket of the anchor. When the anchor takes the curve, the ball drops off, enters the water before the anchor and runs out its cable to a predetermined length. Its weight then retracts a pawl which allows the anchor drum to revolve and the mine cable to pay out. The buoyancy of the mine causes it to float; while the anchor and ball sink, remaining a fixed distance apart. When the ball strikes the bottom, however, its weight is no longer supported by the pawl, which springs back and locks the cable drum. Hence the mine is drawn under the water until the anchor itself strikes the bottom. The submergence of the mine is thus predeterminable without regard to the depth of water and is about equal to the length of the sounding-ball cable. The firing lever of the mine is sealed against motion by sal ammoniac, so that it cannot be actuated during launching. In the water, however, this dissolves.

In some cases it is arranged for the mine and anchor to sink together; then when they strike the bottom, the mine is released and ascends to its proper position.

Floating mines are arranged to float just submerged, so as to be difficult to see and are often strung together by a cable so as to be swung in against a ship striking the cable. They are especially useful to hamper a pursuing vessel. Barrage mines are used to defend narrow channels against entrance; a number of small mines are usually connected and strung across the channel and are arranged so that only part will explode at one contact, leaving the others for another attack. Counter mines are used to clear a way through a mined channel; usually a number of heavy mines are connected by an electric cable and dropped in a string along the channel for simultaneous explosion.



MINE MECHANISM



SUCCESSIVE STEPS IN LAYING

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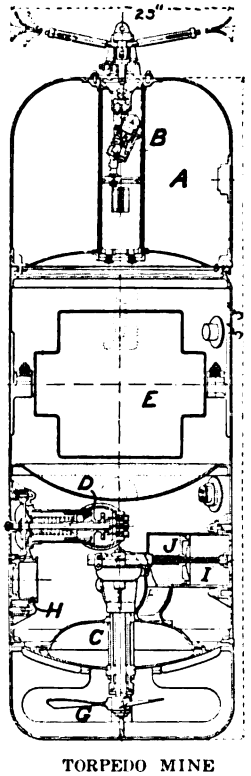
SWIMMING MINE

TORPEDO-MINE WHICH FLOATS FREELY AT PREDETERMINED DEPTH

Le Génie Civil

DESTRUCTION of the Bouvet, Irresistible and Ocean in the Dardanelles is attributed to what are known as torpedo-mines. This type of mine was invented by a Swedish captain, Karl Oscar Leon in 1907. It takes its name from the fact that it is equipped like a torpedo with a motor and a screw; but it differs radically in that its motion is vertical and is oscillatory, the object being to allow it to float with the current or remain practically stationary at any predetermined depth below the surface.



TORPEDO MINE

It is so designed as to remain always upright, as illustrated. The upper third carries the explosive charge in the space *A*, and contact pins and the detonator *B*. The central third carries the storage batteries which are now preferably used for actuating the screw; while the lower third contains the motor and screw and the control devices. An older model used compressed air for actuating the engine and the supply of this fluid to the engine was controlled by the water pressure which compressed a set of bellows or permitted them to expand.

There is in the lower third a small reservoir *C* into which water is admitted, the speed of admission being controlled by a valve. The admission of water to the reservoir increases the weight of the mine so that it sinks. A device *D*, the hydrostat, is then acted upon by the pressure of the water and closes the electrical connection between the storage batteries *E* and the motor *F*. The motor then drives the screw *G* at about 200 revolutions per minute and this exerts an upward thrust which causes the mine to rise; this continues until the pressure of the water decreases to such a point that the hydrostat acts in the reverse direction and breaks the connection, when the screw stops and the mine starts to sink again. The vertical play is about 6 feet.

A clockwork *H* in connection with the mechanism permits shutting the current off definitely at any predetermined time, which allows the mine to sink; it can also be set so that the mine will remain inert on the bottom until a predetermined time, when the current is established and the mine functions again.

The stabiliser *I* consists of a cylinder open to the outside and a watertight piston *J* adjustable by a screw stem. The position of the piston in the cylinder determines the buoyancy of the mine.

Torpedo-mines can be used with advantage to hinder the pursuing enemy in a retreat and can also be allowed to float on the tide into a harbor or other waterway.

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OPINIONS OF THE TECHNICAL PRESS

INCREASING MUNITIONS PRODUCTION

ARE the requirements in material and workmanship in the manufacture of war materials too exacting? Such seems to be the burden of complaints aired in England and occasionally heard in this country. When munitions are made against an indefinite need of the future and time is not an element, closest possible compliance with specifications is attempted without objection. When the munitions are not for indefinite storage, and when, as now, the demands are of an emergency nature and for the maximum quantities that it is possible to get, it is felt that some of the refinements required are largely unnecessary.

The suspicion is that field repairs for one thing are not likely to be made with fine tools, that rough files are likely to be too handy. If, as is claimed, projectiles are used in guns of a slightly larger bore than intended, some of the manufacturing requirements would seem to go for naught. If a steel is sufficiently strong to resist distortion on the explosion which forces it from the gun barrel, so it cannot ruin the barrel rifling, it should not matter exactly how it was rolled. There ought to be no splitting of hairs if speed of production following a method not receiving the approval of the inspector gives a steel which will meet the real demand. In England it is claimed that some of the rather close limits demanded in machining make it difficult to utilize machines which more lenient specifications would allow. There the cry is for some modification in the design or specifications so that special machines will not be needed, but instead that high production may be obtained with existing equipment and at the hands of labor of relatively little skill. For some weeks also requests have been made in England for a consideration of cast iron for shells, predicated in part on the reported discovery of cast iron shells coming from the Teuton lines. The foundries are not so busy that they could not augment the supply of shell cases, and as emergency projectiles for some occasions the British war office has been importuned to consider cast iron.—*The Iron Age.*

THE BIRTH OF A MYTH

THOSE who want to take the trouble may witness the development of a myth from its beginning. This is the belief, already held more or less extensively in Great Britain and Canada, that the American zinc-smelting industry is controlled by Germans, that they boosted the price for spelter to four or five times the normal in order to penalize their enemies and thus carry on warfare in one way if they could not in another. Nothing could be any more ridiculous or contrary to patent facts, yet without any doubt this myth will live and grow. Merely for the sake of the accuracy of the records, however, it is worth while to state the facts.

Interests with German affiliations at the beginning of this year had an aggregate of about 25,000 retorts, a trifle more than 20 per cent of the American total. The control of the zinc-smelting industry has never been centered in any one quarter. It always has been, and still is, divided among a good many independent interests. Other big interests in the business are: American Zinc, Edgar Zinc, Granby, Grasselli Chemical, Hegeler Zinc, Illinois Zinc, Matthiessen & Hegeler, New Jersey Zinc, and United States Zinc. The pedigrees of these concerns are well known.

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The British must look nearer home to find out why the price for spelter was rushed upward so extravagantly. They will find a large part of the explanation in their own policy of "muddling along." Among other exhibitions of the muddling that may be mentioned are the unnecessary refinement in the spelter specifications and the farming out of ammunition contracts in ways that caused buyers in the same ultimate interest to appear as competitors of each other and to figure as being in the market for a great deal more spelter than was really the case. As an exhibition of ignorance, muddled with stupidity, the buying of spelter during the second quarter of 1915 was preëminent.—*The Engineering and Mining Journal.*

AERO ENGINEERING

IT is interesting to note the variety of influences which are working to develop the art of flying to a point where it will be more useful than at present. The greatest of these, of course, is the need for air craft in military operations. However, other fields of usefulness are likely to be lost sight of, and it may be worth while to point out some of these. Recently, on the occasion of an accident to a pleasure boat just off shore from a popular beach resort in California, it was demonstrated that an aeroplane could be used effectively for dropping life preservers to persons struggling in the water beyond the surf line. This incident started a campaign to have the life-saving service equipped with aeroplanes. Post-office officials in Washington have long recognized the advantage of using aero delivery service for crossing the deserts and mountains of the West and North, and in many cases where means of communication are uncertain it seems almost a necessity. Even in well settled Western districts mountain chains often necessitate circuitous rail routes, and these afford opportunity for great time-saving if aerial mail service were established. Those whose duty it is to watch for forest fires, to patrol transmission lines or to carry relief into frozen wastes or the desert areas, and, in short, many whose work is now accomplished under difficulties because of transportation problems, will be able greatly to increase their range and efficiency when the aeroplane as a safe and well controlled conveyance is at their disposal.—*Engineering Record.*

CUT IN BRITISH COAL EXPORTS

THE most significant development in the export trade since the inception of the War is the report to the effect that Great Britain has placed a rigid embargo against all exports, including those to her allies and excepting only British possessions and protectorates. Computed on the basis of the June exports for the current year, the order will mean the withdrawal of 3,561,650 tons of British coal per month from the world's markets, a shortage aggregating more than 42,000,000 tons per annum. We have suffered a sharp decline in our own export shipments. Our gross exports for the 11 months ending May of the current year are 12,500,000 tons, as compared with 14,500,000 for the same period last year, showing a direct loss of 2,000,000 tons covering what is essentially the war period. The tonnage Great Britain is withdrawing from the world's coal markets amounts to approximately three times our normal exports. In view of the fact that we are the only large producing country which can make up this enormous deficiency, these figures are significant.—*Coal Age.*

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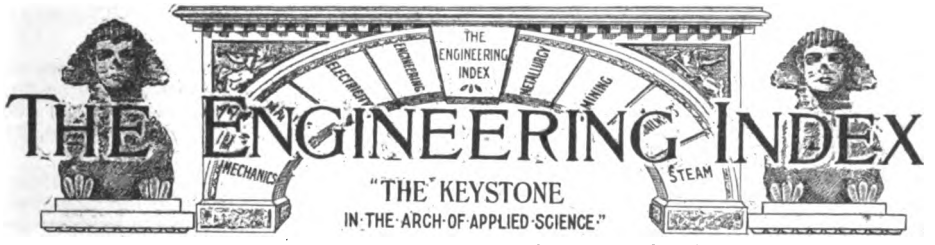

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The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☛ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

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CIVIL ENGINEERING

BRIDGES

Canal

Canal Bridges. E. A. Cross. Descriptive notes concerning the construction and maintenance of some of the bridges of Birmingham Canal Navigations. Ills. 3500 w. Engng—July 30, 1915. Serial, 1st part. No. 63343 A.

Concrete

An Ornamental and Cheap Concrete Bridge. R. C. Hardman. Long girder bridge of reinforced concrete at Canon City, Colo. Ills. 1000 w. Eng News—Aug. 5, 1915. No. 63134.

The Hopple Street Viaduct, Cincinnati. Materials and methods of reinforced concrete construction. Ills. 2500 w. Munic Jour—Aug. 5, 1915. No. 63182.

Unit-Construction System Applied to a Three-Mile Concrete Viaduct to Reduce the Cost. Economy in bridging Yolo By-Pass near Sacramento, Calif. Ills. 3300 w. Eng Rec—Aug. 28, 1915. No. 63711.

The Tunkhannock Concrete Viaduct of the Lackawanna Railroad (Le viaduc en béton de Tunkhannock du Lackawanna Railroad, à Nicholson—Pennsylvania, É.-U.—) P. Calfas. General description.

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Ills. 2000 w. Génie Civil—Aug. 7, 1915. No. 63513 B.

Continuous Truss

Ohio River Bridge for the C. B. & Q. R. R. Ills. 1700 w. Eng News—July 29, 1915. No. 62993.

Elastic Curve Applied to the Design of the Sciotoville Bridge. D. B. Steinman. Application of influence lines to exact determination of stresses. 2500 w. Eng Rec—Aug. 28, 1915. No. 63715.

Erection

Practical Bridge Erection and Maintenance Methods. Second series of contest papers describing solutions of various problems. Ills. 4500 w. Ry Age Gaz—Aug. 20, 1915. No. 63574.

Floors

The Water-proofing of Solid Steel-Floor Railroad Bridges. Continued discussion of Samuel Tobias Wagner's paper. 7000 w. Pro Am Soc of Civ Engrs—Aug., 1915. No. 63643 D.

Paving Problems of Queensboro Bridge, New York. Expansion troubles and methods for remedying them. Ills. 1000 w. Eng News—Aug. 26, 1915. No. 63692.

Highway

Diagrams Facilitate Estimating Highway Bridges. G. F. Burch. Plots curves for steel and concrete required. 1200 w. Eng Rec—Aug. 7, 1915. No. 63197.

Java

The Project for the Serajoe River Bridge of the Proposed Cheribon-Kroja Line of the Java State Railways (Het ontwerp van bovenbouw der overbrugging van de Serajoe-rivier in de aan te leggen lijn Cheribon-Kroia der Staatsspoorwegen op Java). J. H. A. Haarman. Design and details of construction. Ills. 3500 w. Ingenieur—Aug. 7, 1915. No. 63511 B.

Lift

Direct-Lift Span Provides 55-Foot Clearance Over Louisville and Portland Canal. Unusual type of vertical lift span. Ills. 1500 w. Eng Rec—Aug. 14, 1915. No. 63454.

Piers

Building Concrete Caissons in the Platte River. J. H. Merriam. Methods used near Ashland, Neb. Ills. 2000 w. Ry Age Gaz—Aug. 27, 1915. No. 63698.

Reconstruction of Piers of Little Rock Junction Bridge Across the Arkansas River at Little Rock, Ark. Methods used to correct defects. Ills. 4000 w. Engng & Con—Aug. 4, 1915. Serial, 1st part. No. 63093.

Pontoon

Swinging Pontoon Bridge Over the Panama Canal. Bridge at Paraiso. Ills. 500 w. Engng—Aug. 6, 1915. No. 63480 A.

Railway

The Chattanooga Creek Bridge of the N. C. & St. L. C. H. Johnson. Work on 15-track structure. Ills. 1500 w. Ry Age Gaz—Aug. 20, 1915. No. 63572.

Solid Deck Trestles and Bridges on the Illinois Central. Detailed description of reinforced-concrete work. Ills. 800 w. Ry Age Gaz—Aug. 13, 1915. No. 63425.

Swing

Canadian Pacific Draw Span Over the Lachine Canal. Electrically-operated double track deck plate girder swing bridge, near Montreal. Ills. 800 w. Ry Age Gaz—Aug. 6, 1915. No. 63143.

CONSTRUCTION

Balconies

Five Examples of Cantilevered Auditorium Balconies. Long-span cross girders for reducing number of columns. Ills. 900 w. Eng Rec—Aug. 21, 1915. No. 63616.

Ball Parks

National League Ball Park at Boston, Mass. Reinforced concrete stands, fence, and club house. Ills. 1500 w. Eng News—Aug. 19, 1915. No. 63565.

Buildings

Some Industrial Buildings. George C. Nimmons. Illustrations of recent work, with descriptive notes. 2000 w. Archt Rec—Aug., 1915. No. 63052 A.

London County Hall. Report of progress in construction. Ills. 3000 w. Engr, Lond—Aug. 13, 1915. No. 63676 A.

Concrete

Cinder Concrete Floor Construction Between Steel Beams. Continued discussion of the paper by Harold Perrine and George E. Strehan. Ills. 2500 w. Pro Am Soc of Civ Engrs—Aug., 1915. No. 63644 D.

Concreting Plant for Large Chicago Warehouse. Steel-trestle track to be a permanent feature of building used as loading platform for concreting plant. Ills. 1800 w. Eng News—Aug. 12, 1915. No. 63413.

Domes

Concrete Dome for the New Technology Buildings. Views and methods of erection. 900 w. Eng News—Aug. 26, 1915. No. 63689.

Designing a Steel Dome. A. W. Earl and Thomas F. Chace. Methods employed for the steel frame dome of the Horticultural Palace at the Panama-Pacific exposition. Ills. 3900 w. Eng News—July 29, 1915. No. 62990.

Foundations

Novel Method of Excavating for the Foundation of a Bank Building in Stockholm, Sweden. K. P. Billner. Data from *Tecknish Tidskrift*. Brief description. Ills. 800 w. Engng & Con—Aug. 11, 1915. No. 63389.

Pile Tests Indicate Type of Substructure for Technology Buildings. Charles T. Main and H. E. Sawtell. Peculiar soil conditions. Ills. 4000 w. Eng Rec—Aug. 21, 1915. No. 63617.

Extensive Earth Slippage Shuts Down Cement Plant. Extensive subsidence of

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clay bed at Hudson, N. Y. Ills. 1000 w. Eng News—Aug. 12, 1915. No. 63420.

Water-Soaked Bed of Blue Clay Caused Landslip at Cement Plant Near Hudson, N. Y. D. H. Newland. Geological study. Ills. 1800 w. Eng Rec—Aug. 28, 1915. No. 63713.

Gravel Plant

Portable Gravel Screening and Washing Plant. MacRae D. Campbell. Types of screens and design of a semi-portable plant. Ills. 1800 w. Ry Age Gaz—Aug. 20, 1915. No. 63573.

Lightning Protection

Protecting Buildings Against Lightning. George H. Armstrong. Functions and effectiveness of lightning rod. Ills. 3000 w. Elec Wld—Aug. 21, 1915. No. 63606.

Piers

Chicago Municipal Pier. For freight and passenger steameres. Criticisms. Ills. 3600 w. Eng News—July 29, 1915. No. 62988.

Superstructure of Chicago Municipal Pier. Details of construction plant and methods for steel and concrete pier sheds. Ills. 1500 w. Eng News—Aug. 12, 1915. No. 63417.

Ninth Street Pier in Lake Erie at Cleveland, Ohio. Municipal pier for large passenger boats. Ills. 1300 w. Eng News—Aug. 5, 1915. No. 63138.

A Notable Step in the Building of New York's Great Piers. Robert G. Skerrett. Describes work of cofferdamming on North River. Ills. 900 w. Sci Am—Aug. 21, 1915. No. 63619.

Shipping Piers in Southwark District of Philadelphia. Concrete substructures on timber piles; steel and concrete superstructure. Ills. 800 w. Eng News—Aug. 26, 1915. No. 63695.

Concrete Cribs Used Successfully in Dock Construction at Victoria. Methods followed. Ills. 2000 w. Eng Rec—Aug. 7, 1915. No. 63196.

Reclamation

Method and Cost of Making a Drainage Survey for the Washington Bayou Drainage District, Mississippi. O. W. Melin. Survey ordered by the chancellor of the court. Map. 3300 w. Engng & Con—Aug. 4, 1915. No. 63094.

Cost of Electric Dredging for Land Reclamation, San Diego, Cal. L. R. W. Allison. Data on operation. 1000 w. Engng & Con—Aug. 4, 1915. No. 63095.

Speedways

Sheepshead Bay Motor Racetrack. A 2-mile wood-paved track at Brooklyn, N. Y. Ills. 1800 w. Eng News—Aug. 19, 1915. No. 63561.

Stacks

Design and Construction of a 400-Foot Steel Stack at the United Verde Copper Co.'s Plant, Clarkdale, Ariz. Abstract of paper by L. W. Barker, in Jour. of Eng. of Univ. of Colo. Descriptive. Ills. 2000 w. Engng & Con—Aug. 25, 1915. No. 63633.

Design, Construction and Cost of 137-ft. Reinforced Concrete Chimney at Coldwater, Mich. Data from a paper by Keller E. Morton, before Mich. Engng. Soc. 1000 w. Engng & Con—Aug. 11, 1915. No. 63388.

Tunnels

The Astoria Tunnel Under the East River for Gas Distribution in New York City. John Vipond Davies. Comprehensive description. Map & Ills. 22800 w. Pro Am Soc of Civ Engrs—Aug., 1915. No. 63641 D.

Belt Conveyors Will Help Simultaneous Driving and Lining of Air Tunnel. G. D. Emerson. Work in Dorchester tunnel in Boston. Ills. 2000 w. Eng Rec—Aug. 21, 1915. No. 63610.

The Largest Tunnel in the World. A 4-mile tunnel 72-ft. in width and 40 ft. high to carry ship canal. Ills. 1200 w. Eng News—Aug. 26, 1915. No. 63690.

New York Subway Tapped for New Connections While Carrying Heavy Traffic. Difficult construction work where Lexington Ave. line joins existing tubes at 42nd St. Ills. 1800 w. Eng Rec—Aug. 28, 1915. No. 63714.

Methods of Construction on the Twin Peaks Tunnel. Summary of progress on this San Francisco tunnel. Ills. 1000 w. W Engng—Aug., 1915. No. 63198.

See also Subways under STREET AND ELECTRIC RAILWAYS; and Tunnels under RAILWAY ENGINEERING, *Permanent Way and Buildings.*

MATERIALS OF CONSTRUCTION

Asbestos Roofing

Corrugated Asbestos Roofing and Siding. Material and its application. Ills. 800 w. Ir Age—Aug. 19, 1915. No. 63555 A.

Cement

The Cement Industry in the United States in 1914. Ernest F. Burchard. Statistical. 35 pp. U S Geol Surv, II:16—Aug. 23, 1915. No. 63758 N.

Concrete

Shrinkage and Time Effects in Reinforced Concrete. Franklin R. McMillan. Discussion of results of tests. Ills. 41 pp. Univ of Minn, Engng Study No. 3—March, 1915. No. 63369 N.

Oil-Mixed Portland Cement Concrete. Logan Waller Page. More data based on experiments. Ills. 25 pp. U S Dept Agri, Bull No. 230—July 14, 1915. No. 63222 N.

Points Respecting Reinforced Concrete for Roads, Sewerage, Etc. Arthur E. Collins. Read before Inst. of Munic. & Co. Engrs. Experience with its use. 2500 w. Surveyor—Aug. 13, 1915. No. 63669 A.

Temperature Changes in Mass Concrete. Discussion of the paper by Charles H. Paul and A. B. Mayhew. 6000 w. Pro

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Am Soc of Civ Engrs—Aug., 1915. No. 63646 D.

Investigation of the Durability of Cement Drain Tile in Alkali Soils. R. J. Wig and J. M. Williams. Field study. Ills. 56 pp. U S Bur of Stand—Tech Paper No. 44. No. 63274 N.

Lime

Operation of Gas Producers for Lime Burning. John J. Porter and J. Clyde Whetzel. Best practice. 1200 w. Nat Lime Mfrs Assn—Aug., 1915. No. 63735.

A Modern Hydrated Lime Plant. Richard K. Meade. Plant at Dover Plains, N. Y. Ills. 2000 w. Nat Lime Mfrs Assn—Aug., 1915. No. 63736.

Lime Hydrating Plant of the National Mortar & Supply Co. A. H. Lauman. Plant at Gibsonburg, Ohio. 1500 w. Nat Lime Mfrs Assn—July, 1915. No. 63310 N.

Paving Brick

Rattler Test for Paving Brick Abandoned in St. Louis. Mont Schuyler. Standard sample of 100 bricks substituted. 1500 w. Eng Rec—Aug. 14, 1915. No. 63455.

Sheet Piling

Encased Sheet Piling (Ummantelte Spundwandeisen). W. Gutacker. Various sections with various styles of reinforcement. Ills. 800 w. Beton u Eisen—July 3, 1915. No. 63200 B.

MEASUREMENT

Arches

A Simple Method for Determining Two-Hinged Arch Reactions. C. S. Whitney. Application of Culmann's graphic method. 700 w. Engng & Con—Aug. 18, 1915. No. 63551.

Beams

Calculation and Experiments with Beams Continuous with Their Supports (Calcul et expérimentation des poutres solidaires de leurs supports). P. Caufourier. Results from work with models. Ills. 1800 w. Génie Civil—Aug. 7, 1915. No. 63514 B.

Time and Shrinkage Affect Stresses and Deflections of Reinforced-Concrete Beams. Long-time tests made by F. R. McMillan. 2000 w. Eng Rec—Aug. 28, 1915. No. 63712.

The Designing of Reinforced-Concrete Beams: Some Data Tending to Show Errors in Present Theory and Practice. L. J. Mensch, in *Jour. Am. Concrete Inst.* Data and discussion. (Abstract.) 4000 w. Engng & Con—Aug. 11, 1915. No. 63387.

Bridge Impact

Allowing for Impact in Bridge Calculations. J. D. W. Ball. British and American practice. Ills. 3500 w. Engr, Lond—Aug. 13, 1915. No. 63677 A.

Concrete

Review and Readjustment of the Common Methods of Calculating Reinforced-Concrete Sections for Bending and Compression (Kritik und Richtigstellung der gebräuchlichen Methoden zur Berechnung von Eisenbetonquerschnitten auf Biegung und Druck). B. Löser. Mathematical. Ills. 3500 w. Beton u Eisen—July 3, 1915. Serial, 1st part. No. 63201 B.

Economical Calculation of Reinforced-Concrete Sections Under Eccentric Compression (Wirtschaftliche Bemessung von Eisenbetonquerschnitten unter exzentrischem Druck). R. E. Steinsberg. Mathematical. Ills. 1500 w. Beton u Eisen—July 3, 1915. No. 63203 B.

Filing

Filing and Indexing of Office Computations. Frank H. Jones. Advantages of bound volumes and loose sheets filed in binders. 2000 w. Eng Rec—July 31, 1915. No. 63016.

Flow

Contribution to the Calculation of the Coefficient of Friction of Water Under Pressure in Conduits (Contributo al calcolo del coefficiente d'attrito nelle condotte d'acqua in pressione). A. Vecchi. Results from experiments. Ills. 2500 w. Monit Tec—June 30, 1915. No. 63216 B.

Loss of Head from Sharp-Angled Turns (La perdita di carico nei gomiti ad angolo vivo). U. Puppini. Formulas and figures from experimental research. Ills. 2000 w. Monit Tech—July 20, 1915. Serial, 1st part. No. 63255 B.

See also MECHANICAL ENGINEERING, *Hydraulic Machinery.*

Foundations

Pressures on Piles Supporting Masonry. R. V. P. Marquardsen. Mathematical. Ills. 1200 w. Jour W Soc of Engrs—June, 1915. No. 63374 B.

Fracture

Two Noteworthy Fracture Phenomena in Construction Members (Zwei beachtenswerte Brucherscheinungen an Konstruktionsteilen). R. Loebe. Study of causes, and nature of the steel. Ills. 2500 w. Z V d I—July 17, 1915. No. 63223 B.

Lime

Measurement of the Plasticity of Hydrated Lime by the Compression Method. Warren E. Emley. Outlines new method. 1200 w. Natl Lime Mfr Assn—July, 1915. No. 63351 N.

River Discharge

A Method of Correcting River Discharge for a Changing Stage. Benjamin E. Jones. Explanation and results of tests. Ills. 3000 w. U S Geol Surv Water-Supply Paper 375-E—Aug. 16, 1915. No. 63499 N.

Statics

Contribution to the Statics of Grouped Supports and Bearing Foundations (Beitrag zur Statik der Stützengruppen und Tragestelle). V. Lewe. Mathematical; considers rigidly connected systems. Ills. 2000 w. Beton u Eisen—July 3, 1915. No. 63202 B.

Stream Gaging

The Relation of Stream Gaging to the Science of Hydraulics. C. H. Pierce and

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R. W. Davenport. 3000 w. U S Geol Surv, Water-Supply Paper 375-C—June 26, 1915. No. 63757 N.

Surveying

Results of Spirit Leveling in Iowa, 1896 to 1913, Inclusive. R. B. Marshall. 120 pp. U S Geol Surv Bul 569. No. 63737 N.

Results of Spirit Leveling in Missouri, 1896 to 1914, Inclusive. R. B. Marshall. 204 pp. U S Geol Surv, Bul 568. No. 63739 N.

A New Telemetric Instrument (Per un nuovo telemetro). G. Delitala. Novel surveying instrument. Ills. 1500 w. Monit Tech—July 20, 1915. No. 63256 B.

Tension

The Effect of the End Connections on the Distribution of Stress in Certain Tension Members. Cyril Batho. Experiments and analysis of results. 9000 w. Jour Fr Inst—Aug., 1915. No. 63394 B.

Wind Stresses

Wind Stresses in the Steel Frames of Office Buildings. W. M. Wilson and G. A. Maney. Method more accurate than those in use. Tables and figures. 88 pp. Univ of Ill, Bul 80—June 7, 1915. No. 63352 N.

MUNICIPAL

City Government

Commission and City Manager Forms of Government. Examples. 6000 w. Munic Engng—Aug., 1915. No. 63147 A.

Dayton's Progress Under Commission-Manager. William S. Crandall. Best administration the city has had. 1200 w. Munic Engng—Aug., 1915. Serial, 1st part. No. 63149 A.

Fire Protection

Cincinnati's Fire Department. General description. Ills. 3300 w. Munic Jour—Aug. 26, 1915. No. 63688.

Montreal

Montreal Water and Power Extensions. J. A. Jamieson. Critical notes outlining situation. 5000 w. Can Engr—Aug. 12, 1915. No. 63438.

Repair Shops

Central Plant at Chicago Will Handle Repairs to All City Equipment. Construction features. Ills. 1800 w. Eng Rec—Aug. 28, 1915. No. 63718.

Sewage Disposal

Brief Notes of Experiments in Sewage Purification by Forced Aëration. J. P. Wakeford. Read before Inst. of Munic. & Co. Engrs. Also discussion. 7000 w. Surveyor—July 30, 1915. No. 63347 A.

Seven Years' Experience with a Large Sludge-pressing Plant. John T. Thompson. Experimental work; manurial value of sludge; by-products. 4000 w. Surveyor—July 23, 1915. No. 63114 A.

Brooklyn Sewage-Aëration and Activated-Sludge Experiments. E. J. Fort. Results of experiments with and without activated sludge. Ills. 2400 w. Eng News—July 29, 1915. No. 62991.

Sewage Disposal at Southall-Norwood. Reginald Brown. From a paper before Inst. of Munic. & Co. Engrs. Detailed description. Ills. 3000 w. Surveyor—July 30, 1915. No. 63348 A.

Sewage Handling

Automatic Sewage-Pumping and Metering Station. Alan A. Wood. New system at Providence, R. I. Ills. 900 w. Eng News—Aug. 12, 1915. No. 63414.

Sewerage

Design Feature of New Sewerage System and Sewage Disposal Works for Cleburne, Tex. R. E. McDonnell. Old and new systems. Ills. 2200 w. Engng & Con—July 28, 1915. No. 62983.

The New British Non-Septic House and Town Sewage Drainage and Sewage-Drainage Ventilation Systems of the Twentieth Century and After. Isaac Shone. From a paper before the Munic. & Co. Engrs. Describes apparatus of the Shone system. Ills. 3300 w. Archt, Lond—Aug. 13, 1915. No. 63650 A.

Sewers

Circular Sewers Versus Egg-shaped, Catenary and Horseshoe Cross-Sections. R. DeL. French. Comparisons by curves. 1200 w. Eng Rec—Aug. 21, 1915. No. 63612.

Beat Scheduled Time Five Months in Building Huge De la Brea Sewer. Los Angeles built largest and most expensive storm sewer in the West. Ills. 2500 w. Eng Rec—July 31, 1915. No. 63017.

Smoke Abatement

Reducing Smoke in Pittsburgh. J. W. Henderson. Change in ordinances and results. Ills. 1000 w. Power—Aug. 3, 1915. No. 63068.

Strassburg

Dual Ownership of Public Utilities in Alsace. Milo A. Jewett. Methods applied in Strassburg. 2000 w. Munic Engng—Aug., 1915. No. 63148 A.

Streets

Municipal Control of Street Planning. Andrew Linn Bostwick. Abstracts of laws of cities, states and Canadian provinces. 3000 w. Munic Jour—July 29, 1915. No. 62984.

Cutting a City Street Through a Railway Station. Work at Springfield, Mass., to connect two dead-end streets. Ills. 1800 w. Eng News—Aug. 12, 1915. No. 63415.

Wastes

The Preparation of Fertilizer from Municipal Waste. J. W. Turrentine. Classes of city waste that could be utilized. Ills. 5500 w. U S Dept of Agri—From Year Book, 1914. No. 63023 N.

ROADS AND PAVEMENTS

Asphalt

Methods and Cost of Laying Asphaltic Wearing Surface on Concrete Pavement, Santa Barbara County, California. Describes only work of asphaltic surfacing.

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Ills. 1500 w. Engng & Con—Aug. 18, 1915. No. 63552.

Asphalt Block

Maintenance and Repair of Asphalt Block Pavements. Edwin J. Morrison. Practice of experienced engineer. Ills. 3000 w. Eng News—Aug. 19, 1915. No. 63564.

Asphalt Plant

Bronx Borough Asphalt Plant. Construction and details. Ills. 1500 w. Munic Jour—Aug. 12, 1915. No. 63406.

Bituminous

Laying a New Bituminous Pavement at West Pittston. Methods, appliances and cost. Ills. 2000 w. Munic Jour—Aug. 5, 1915. No. 63183.

Brick

Vitrified Brick Pavements for Country Roads. Vernon M. Peirce and Charles H. Moorefield. General information. Ills. 15700 w. U S Dept of Agri—No. 246. No. 62978 N.

Concrete

Portland Cement Concrete Pavements for Country Roads. Charles H. Moorefield and James T. Voshell. Their construction, advantages and disadvantages. Ills. 34 pp. U S Dept of Agri, Bul 249—July 26, 1915. No. 63349 N.

Method of Striking Off Wide Concrete Street Pavements and Those Having a Varying Crown. H. Colin Campbell. Method successfully used. Ills. 1500 w. Engng & Con—July 28, 1915. No. 62981.

Aggregate for This Job Is Mechanically Handled from Pit to Road. Work on 11½ miles of Lincoln Highway concrete road near South Bend, Ind. Ills. 1200 w. Eng Rec—July 31, 1915. No. 63018.

Dust Prevention

Progress Reports of Experiments in Dust Prevention and Road Preservation, 1914. Reports of experiments at 16 places. 44 pp. U S Dept of Agri, Bul 257—July 12, 1915. No. 62979 N.

Granite

Track Renewal Discloses Perfect Condition of 14-Year Old Granite Pavement. Grouted granite block on Main St, Worcester, Mass. Ills. 1500 w. Eng Rec—Aug. 21, 1915. No. 63615.

Maintenance

The Improvement and Maintenance of Highways in Connection with Modern Traffic Conditions. C. F. Gettings. Read before the Munic. & Co. Engrs. Deals particularly with county main roads. 3500 w. Archt, Lond—July 30, 1915. No. 63329 A.

The Improvement and Maintenance of Highways to Meet Modern Traffic Conditions. John S. Brodie. Read before the Inst. of Munic. & Co. Engrs. Urban and suburban roads in United Kingdom. 1800 w. Archt, Lond—Aug. 6, 1915. No. 63649 A.

Maintaining Concrete and Brick Roads in Illinois. B. H. Piepmeier. Methods and costs. Ills. 2300 w. Eng News—Aug. 12, 1915. No. 63418.

Demonstration Road Maintenance on the Washington-Atlanta Highway. E. W. James. Facts about the work, cost, betterment and the possibilities. Ills. 2500 w. Mfrs' Rec—Aug. 26, 1915. No. 63684.

Patrol System of Road Maintenance and Repair in Pennsylvania. Account of system to go into effect Aug. 1st. 1500 w. Engng & Con—July 28, 1915. No. 62982.

New York Highways

Construction and Maintenance of New York State Highways. Arthur H. Blanchard. Review of the 1915 report of the advisory board on highways. 2500 w. Sch of Mines Qr—Jan., 1915. No. 63723 B.

Opening Pavements

Trench Openings and Reinstatements. Reginald Brown. Read before Inst. of Munic. & Co. Engrs. Openings in pavements for various causes, and suggestions for remedying troubles. 2000 w. Surveyor—July 23, 1915. No. 63115 A.

Patented Pavements

Practice Relating to Patented Pavements in American Municipalities. M. T. Calef. Reprint from a thesis submitted to Columbia Univ. Present methods. 10500 w. Engng & Con—Aug. 11, 1915. No. 63386.

Paving

The Paving of Streets. H. J. Fixmer. The responsibility of the engineer in designing. 4500 w. Jour Assn of Engng Socs—July-Aug., 1915. No. 63392 A.

Philippines

Philippine Road Built at High Level to Escape Flood Damage. Baguio-Bauang route replaces Benguet road which involved excessive maintenance charges. Ills. 2500 w. Eng Rec—Aug. 28, 1915. No. 63717.

Road Machines

Operation Analysis of New Machines Which Cheapen the Moving of Earth on Road Work. A. B. McDaniel. Conditions affecting the cost of operation of new types of graders and scrapers, and the light steam shovel. Ills. 3000 w. Eng Rec—July 31, 1915. No. 63015.

State Roads

State Management of Public Roads: Its Development and Trend. J. E. Pennybacker. State aid systems and work. Ills. 4500 w. U S Dept of Agri—Year Bk., 638. No. 63311 N.

WATER SUPPLY AND IRRIGATION

Arizona

Ground Water in Paradise Valley, Arizona. O. E. Meinzer and A. J. Ellis. Physiography and drainage, geology, climate, etc. 25 pp. U S Geol Surv, Water-Supply Paper 375-B—July 14, 1915. No. 63756 N.

Dams

The Action of Water Under Dams. J. B. T. Colman. Results of a study of height, length, etc. Ills. 7000 w. Pro

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Am Soc of Civ Engrs—Aug., 1915. No. 63638 D.

Pennsylvania Commission Issues Rules Regarding Dams. Instructions for prospective dam builders. Ills. 1500 w. Eng Rec—Aug. 21, 1915. No. 63613.

Design and Construction of the Lake Watrous Dam of the New Haven Water Co. Clarence M. Blair. Major portion of a paper read before the Conn. Soc. of Civ. Engrs. Descriptive. Ills. 4000 w. Engng & Con—Aug. 11, 1915. No. 63385.

Construction of Dams on the Valier, Montana, Irrigation System. Kennett A. Heron. Erection of two dams of unusual construction. Ills. 1200 w. W Engng—Aug., 1915. No. 63199.

England

Water Undertakings of England and Wales. The new government return, and proposed legislation. 2200 w. Surveyor—Aug. 13, 1915. Serial, 1st part. No. 63668 A.

Filtration

New Filtration Works for Oldham. Works fitted with mechanical filters. Ills. 1800 w. Engr, Lond—July 30, 1915. No. 63345 A.

Galveston

Galveston's Sea-Wall Checks Hurricane's Devastation. E. B. Van de Greyn. Report of damages and attendant phenomena. Ills. 3000 w. Eng Rec—Aug. 28, 1915. No. 63719.

Galveston Survives Hurricane. Report of damage. Ills. 1200 w. Eng News—Aug. 26, 1915. No. 63696.

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Simple explanation of best practice with exceedingly intelligible illustrations.

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Brass Foundries

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The Future of British Engineering and Shipbuilding. E. W. Frazer-Smith. Causes of backwardness and directions of possible progress. Discussion. 54 pp. Trans N-E Coast Inst of Engrs & Shipbldrs—July, 1915. No. 63729 N.

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How to Secure Foreign Trade. Frederic Schreibman. Second articles of a series setting forth the peculiarities of European selling methods. 3500 w. Engng Mag—Sept., 1915. No. 63755 A.

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Notes on Social Mechanics: The Universal Energy (Notes de mécanique sociale: L'énergie universelle). A. Portuondo. Partial translation of Spanish book applying mechanical laws, such as thermodynamical principles, to human life both individual and collective. 4800 w. Rev gen des Sciences—July 30, 1915. No. 63259 B.

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The Industrial Factor in the War. Arthur Shadwell. An explanation of the importance of the industrial element in the present war. 8000 w. Nineteenth Cent—Aug., 1915. No. 63740 B.

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A boosting handbook.

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Fourteenth Annual Report of the Commissioner of Labor of the State of New York. By James M. Lynch. 6 x 8½"; pp. 659. Albany.

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Russian Equivalent Tables. Folder; size, 4¼ x 5¼"; pp. 6. Price, $0.40. London: Central Translations Institute, Ltd.

Money, weights, and measures conversion tables.

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New Graving Dock at South Shields. Methods of construction. Ills. 1500 w. Engr, Lond—Aug. 13, 1915. No. 63678 A.

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Launching of the Battleship Arizona. G. H. Barber. General description. Ills. 2000 w. Int Marine Engng—Aug., 1915. No. 63100 A.

The Red Star Liner Belgenland. Triple-screw passenger steamer of 33000 tons displacement launched at Belfast. Ills. 2500 w. Int Marine Engng—Aug., 1915. No. 63101 A.

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The Shape of the Water Stream from a Propeller and its Absorption of Energy (Die Form des Schraubenstrahles und seine Energieänderung). H. Krey. Study of eddy action. Ills. 1200 w. Z V d I—July 24, 1915. No. 63297 B.

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On the Procedure of Calculating Stability (Ueber die Ausführung von Stabilitätsberechnungen). Ludwig Benjamin. Description of graphic method. Ills. 1500 w. Schiffbau—Aug. 11, 1915. No. 63542 B.

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The Turbine Passenger Steamships Great Northern and Northern Pacific. Ocean-going express steamships recently put into service between Astoria, Ore., and San Francisco. Ills. 3000 w. Engr, Lond—Aug. 6, 1915. No. 63484 A.

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Balloons

Using Air for Ballast. R. H. Upson. Theory of vertical control of balloons. 1800 w. Sci Am Sup—Aug. 28, 1915. No. 63702.

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A Study of an Axle Shaft for a Motor Truck. John Younger. Splining affects torsional strength; remedied by heat treatment. Ills. 2000 w. Horseless Age—Aug. 1, 1915. No. 63126.

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Design and Performance of Ball Bearings. B. D. Gray. Read before Elec. Veh. Assn. of Am. Shapes of parts, accuracy in dimensions, and consideration in use. Ills. 2000 w. Ir Age—Aug. 5, 1915. No. 63098 A.

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The Care and Upkeep of Batteries for Lighting, Ignition, and Engine Starting. D. H. Ogley. Hints. Ills. 1500 w. Autocar—July 24, 1915. Serial, 1st part. No. 63109 A.

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Car and Carbureter Design Suitable for Driving with Any Fuel. Study of modern carbureters. Extract from article by Baron von Löw. Ills. 4000 w. Automobile—Aug. 12, 1915. No. 63412.

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Cutting the Weight. A. Ludlow Clayden. Scientific design and use of aluminum alloys. Ills. 4000 w. Automobile—Aug. 5, 1915. No. 63132.

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Possible Troubles with Aluminum Motor. A. Ludlow Clayden. Details and their seriousness. 1000 w. Automobile—Aug. 12, 1915. No. 63411.

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Investigation and Operating Results with Substitutes for Benzine for Driving Motor Vehicles (Versuchs und Betriebsergibnisse mit Benzin-Ersatzstoffen beim Betrieb von Kraftwagen). Freiherr von Löw. Substances and modifications of apparatus. Ills. 3000 w. Auto Rund—June, 1915. No. 63215 B.

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Governing Motor Speed in Commercial Vehicles. Frank H. Trego. Suggestions, with discussion. 4500 w. S A E Bul—July, 1915. No. 63365 B.

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A New Principle in Motor Car Ignition. The Varley three-coil transformer. Ills. 1200 w. Horseless Age—Aug. 15, 1915. No. 63498.

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Field Experience with Motor Trucks (Felderfahrungen mit Kraftwagen). K. Bilau. Weaknesses as brought out by poor Russian roads. Ills. 1500 w. Auto Rund—July, 1915. No. 63518 B.

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A Formula for the Comparison of Gasoline Automobile Performance. Cornelius T. Myers. Gives derivation of formula and applications. Short discussion. 2500 w. S A E Bul—July, 1915. No. 63363 B.

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Factors in Valve-in-Head Design. W. A. Brush. Refinements and developments. Ills. 1500 w. Automobile—Aug. 19, 1915. No. 63494.

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Diesel Engines

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Ammonia

On the Decomposition of Ammonia. R. Plank. Operation of ice and refrigeration plants. Behavior of gases under pressure. 2500 w. Ice & Refrig—Aug., 1915. Serial, 1st part. No. 63070 A.

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Central Heating. Charles L. Hubbard. Compared with small individual heating plants. 2000 w. Nat Engr—Aug., 1915. Serial, 1st part. No. 63010.

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Heating and Ventilating Large Factories. O. H. Bathgate. Operation of a

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The Establishment of Standard Methods of Proportioning Direct Radiation and Standard Sizes of Steam and Return Mains. James A. Donnelly. Part of report of joint committee of Natl. Dist. Heat. Assn. and this Soc. 5000 w. Jour Am Soc of Heat & Vent Engrs—July, 1915. No. 63377 D.

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The Care and Management of Refrigerating Plant. Sidney F. Walker. Hints for those in charge. Ills. 1500 w. Mech Wld—Aug. 6, 1915. Serial, 1st part. No. 63474 A.

Operating a Refrigerating Plant. Thomas G. Thurston. Information about running ammonia compression system. 2000 w. Power—Aug. 10, 1915. No. 63320.

Oil Troubles Experienced in the Refrigeration System. A. G. Solomon. Individual lubricators better than central one. 1500 w. Power—Aug. 17, 1915. No. 63466.

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An Experiment in Ventilating a School Room. Experiments of Chicago Commission on Ventilation. Ills. 4000 w. Jour Am Soc of Heat & Vent Engrs—July, 1915. No. 63378 D.

HYDRAULIC MACHINERY

Centrifugal Pumps

Some Field Experiences with Centrifugal Pumps (Einige Betriebserfahrungen an Zentrifugalpumpen). Franz Koneczny. Points in design of details. Ills. 1500 w. Mont Rund—Aug. 1, 1915. No. 63525 B.

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Jig and Fixture Mechanisms. George M. Meyncke. A collection of quick-acting and equalizing jig clamping devices. Ills. 2500 w. Mach, N Y—Aug., 1915. No. 63001 A.

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Three Adaptable Milling Fixtures. Christian F. Meyer. Designs embodying features applicable in a variety of cases. Ills. 2000 w. Mach, N Y—Aug., 1915. No. 62999 A.

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Calculation of Stepped Pulleys and Speed Ratios for a "Strong-Arm" Work Bench by Means of a Kinematic Study (Het berekenen van trapschijven en versnelling van een "sterke-armschaafbank" door middel eener kinematische beschouwing). L. G. Stokvis. Largely mathematical. Ills. 2000 w. Ingenieur—July 31, 1915. No. 63250 B.

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Ashes Handling

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Modern Bullets in War and Sport. C. Marsh Beadnell. Design and ballistics. Ills. 3500 w. Engng—Aug. 6, 1915. Serial, 1st part. No. 63476 A.

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The Photostat and Its Use. Luther D. Burlingame. Quick and low-cost method of making reproductions of any flat copy that can be photographed. Ills. 2500 w. Mach, N Y—Aug., 1915. No. 62997 A.

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Modern Munitions of War. Vivian B. Lewes. Three lectures on guns and propellants; shells and high explosives; poison gas and incendiary bombs. 9500 w. Jour Soc of Arts—Aug. 6, 1915. No. 63648 A.

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Combustion and Smokeless Furnaces. By Jos. W. Hayes. Size, 6 x 9"; pp. 118. Ills. Price, $2. Chicago: Jos. W. Hayes.

Design, installation and operation of boiler furnaces.

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Principles. design, classification and specific examples.

MINING AND METALLURGY

COAL AND COKE

Byproduct Production

The Influence of Steam on the Extraction of Ammonia in the Igneous Decomposition of Solid Fuels (Einfluss des Wasserdampfes auf die Ammoniakausbeute bei der pyrogenen Zersetzung fester Brennstoffe). Kurt P. Sachs. Conclusions from experiments. Ills. 3500 w. St u E—Aug. 5, 1915. No. 63522 B.

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Products and By-Products of Coal. Edgar Stansfield and F. E. Carter. Progress and development. 51 pp. Can Dept of Mines—No. 323. No. 63309 N.

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Fire Prevention at Coal Mines. H. S. Mikesell. Résumé of precautions and rules of action. 2500 w. Coal Age—July 31, 1915. No. 63028.

The Cause, Prevention, and Method of Dealing with Underground Fires. S. A. Jones. Causes and best methods of extinguishing and preventing. Ills. 2700 w. Bul Can Min Inst—Aug., 1915. No. 63360 N.

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Lucerne Power Plant and Tipple of the Rochester & Pittsburg Coal and Iron Co. with Notes on the Jefferson & Clearfield Coal & Iron Co.'s Plant at Ernest, Penna. C. M. Young. Ills. 3500 w. Col Engr—Aug., 1915. No. 63073 A.

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Montana

Bull Mountain Coal Field, Montana. J. P. Rowe and Roy Wilson. Geology of deposits. Maps. 3500 w. Col Engr—Aug., 1915. Serial, 1st part. No. 63074 A.

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South America

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Fuel Economy on Locomotives. Code of instructions submitted to the Am. Ry. Mas. Mech. Assn. for possible adoption. Ills. 4400 w. Ry Rev—Aug. 7, 1915. No. 63316.

Locomotive Boilers

Staybolts. C. A. Seley. Maximum allowable stress on stays and braces. Short discussion. 4500 w. Pro S & S-W Ry Club—July, 1915. No. 63727 A.

What Method of Driving Staybolts and Radial Stays Gives the Best Results and Service in Locomotive Boilers? Committee report; and discussion. 11 pp. Pro Mas Boil Mak Assoc—1915. No. 63268 N.

Locomotive Flues

Handling and Applying Locomotive Flues. R. B. Van Wormer. Variable conditions, methods, materials and influences affecting life and cost. 16000 w. Pro S & S-W Ry Club—July, 1915. No. 63728 A.

Locomotives

The Locomotive of the Future. Herbert T. Walker. The only increase of dimensions is in length. Solution proposed by George R. Henderson. Ills. 900 w. Sci Am—Aug. 21, 1915. No. 63618.

Measuring the Wheelbase of Locomotives, the Radius and Angle of the Crank and the Rods (Messen des Radstandes der Lokomotiven, der Kurbel-Halbmesser und Winkel und der Stangenlängen). Gustav Rosenfeldt. Methods and description of instrument. Ills. 1500 w. Glasers Ann—Aug. 1, 1915. No. 63524 B.

New Locomotives for the Burlington, the Colorado and Southern, and the Ft. Worth and Denver. Illustrates and describes types. 2500 w. Ry & Loc Engng—Aug., 1915. No. 63081 A.

Pacific Type Locomotives for the Burlington. Special attention given to light weight in reciprocating parts. Ills. 1000 w. Ry Age Gaz—Aug. 13, 1915. No. 63424.

Pacific Type Locomotives for the Chicago, Burlington & Quincy R. R. De-

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tailed description. Ills. 1200 w. Ry Rev —Aug. 7, 1915. No. 63313.

Number and Types of Locomotives on British Railways. Particulars for the year 1914. 1000 w. Engr, Lond—July 30, 1915. No. 63346 A.

"Double-ender" Military Locomotives. Herbert T. Walker. Brief description of engines for the French government. Ills. 600 w. Sci Am—Aug. 14, 1915. No. 63421.

New 4-4-4 "Reading" Type Locomotive. Heavy passenger engine recently built. Ills. 1500 w. Ry Mas Mech—Aug., 1915. No. 63682 A.

Decapod Locomotives for the Russian State Railways. Large orders placed. Ills. 700 w. Ry Rev—Aug. 28, 1915. No. 63767.

Locomotive Tanks

What Is the Most Economical Method for Constructing New Locomotive Tanks and What Advantages Have the New Designs Over the Old Style? Committee report; and discussion. 5 pp. Pro Mas Boil Mak Assoc—1915. No. 63269 N.

Motor Cars

Capacity Magnitude of the Storage-Battery Motor Cars of the Prussian State Railway (Leistungsgrössen der Akkumulatortriebwagen der preussichen Staatsbahnwaltung). Heumann. Data on operation. Ills. 2400 w. E K u B—July 24, 1915. Serial, 1st part. No. 63299 B.

Scale-Testing Cars

Relative Merits of Long and Short Wheel Base Scale-Testing Cars. C. A. Briggs. Read before the Nat. Assn. of Scale Experts. Discusses present practice in the use of scale testing cars. Ills. 3500 w. Ry Rev—Aug. 14, 1915. No. 63440.

Shops

Organization and Shop Methods at Morris Park. Shops of the Long Island R. R. Ills. 3500 w. Ry Mas Mech—Aug., 1915. No. 63683 A.

New Car Repair Plant, Philadelphia & Reading Ry., St. Clair, Pa. Most of ground area covered by traveling cranes. Ills. 2200 w. Ry Rev—Aug. 7, 1915. No. 63312.

Steel Cars

Steel Coaches for Long Island Suburban Service. Exceptionally low first cost and light weight. Ills. 2000 w. Ry Age Gaz—Aug. 6, 1915. No. 63144.

Superheaters

Advantages of the Superheater Locomotive. G. A. Stone. Benefits and operation. 1500 w. Ry & Loc Engng—Aug., 1915. No. 63080 A.

Train Lighting

Recent Improvements in the Electric Lighting of Steam Railroad Cars. R. C. Lanphier. Axle generator system; recent improvements. Ills. 5500 w. Pro Am Inst of Elec Engrs—Aug., 1915. No. 63594 D.

The Electric Lighting Installation of the Bavarian Hospital Train No. 2 (Die elektrische Beleuchtungsanlage des bayerischen Lazarettzuges Nr. 2). Westenhagen. Description of equipment. Ills. 1600 w. E K u B—July 24, 1915. No. 63500 B.

Trucks

An Equalized Four-Wheeled Leading Truck for Locomotives. Recent design of the Pennsylvania R. R. is described. Plate. 1200 w. Engng—July 30, 1915. No. 63341 A.

NEW PROJECTS

Alaska

Government Railway of Alaska. W. R. C. Morris. Notes of an inspection of the location of the Alaska Central Ry. Ills. & Map. 1500 w. Can Engr—Aug. 12, 1915. No. 63437.

Utah

The Bingham and Garfield Railway—A Short Road in Utah with Some Unusual Features. H. C. Goodrich. Detailed description. Maps & Ills. 5500 w. Jour W Soc of Engrs—June, 1915. No. 63372 B.

PERMANENT WAY AND BUILDINGS

Coaling Plants

Summary and Details of Railway Coaling Plants. Types in use. Ills. 2000 w. Ry Engng & Main of Way—Aug., 1915. No. 63766 A.

Flood Damage

Flood Damage to Railroads in Middle West. Damage at Galveston, St. Louis, Valley Park, and other points. Ills. 800 w. Ry Age Gaz—Aug. 27, 1915. No. 63700.

Fuel Oil Stations

Fuel Oil Stations for Extreme Climatic Conditions. Plan, elevation and description of stations of the Grand Trunk Pacific. 1000 w. Ry Gaz, Lond—Aug. 6, 1915. No. 63665 A.

Maintenance

Railroad's Maintenance Expenses Allocated Between Freight and Passenger Service. Percentages used, and reasons therefore, rate-case studies made by William J. Wilgus for the Ulster & Delaware R. R. 4000 w. Eng Rec—Aug. 21, 1915. No. 63614.

The Tool Equipment for Maintenance of Way Forces. Suggested lists for different classes of work. Ills. 3500 w. Ry Age Gaz—Aug. 20, 1915. No. 63570.

Rail Stresses

Lateral Stresses on Rails in Curved Tracks. George L. Fowler. Experiments with various types of locomotives; tenders and cars. Ills. 3000 w. Ry Age Gaz—Aug. 20, 1915. No. 63567.

Roadbeds

History of the Suisun Sinks. A. A. Willoughby. The final conquest of a costly roadbed in California. Ills. 3000 w. Ry Engng & Main of Way—Aug., 1915. No. 63765 A.

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The Reinforced Concrete and Brick Roundhouse of the Buffalo, Rochester & Pittsburg Ry. at Dubois, Pa. Interesting example of recent development. Ills. 2500 w. Engng & Con—July 28, 1915. No. 62980.

Stations

New Pittsburgh North Side Freight Station of the P. R. R. Hartley M. Phelps. Illustrated description. 1400 w. Ry Age Gaz—Aug. 6, 1915. No. 63145.

Subgrades

Railroad Subgrade Troubles—Preventives and Cures. J. T. Bowser. Importance of draining. 1500 w. Eng Rec—Aug. 14, 1915. No. 63457.

Terminals

The Industrial Terminal: Its Evolution and Its Mission. Frank A. Spink. Short paper, with discussion. 4000 w. Pro St Louis Ry Club—July 9, 1915. No. 63726.

Developments at the Grand Central Terminal in New York. Changes since opening, Feb. 2, 1913. Ills. 3000 w. Ry Rev—Aug. 21, 1915. No. 63553.

Track Accessories

Designing Manganese Steel Track Work. V. Angerer. Mistakes and suggestions. 1600 w. Ry Age Gaz—Aug. 20, 1915. No. 63571.

Tunnels

Notable C. P. R. Tunnels in British Columbia. Spiral tunnels in the Kicking Horse valley, the Roger's Pass tunnel through the Selkirk Range, and others. Ills. 2000 w. Can Engr—Aug. 26, 1915. No. 63703.

Tunnel Ventilation

Ventilating the Stampede Tunnel of the Northern Pacific. Unusual problems, and system installed. Ills. 1400 w. Ry Age Gaz—Aug. 6, 1915. No. 63141.

TRAFFIC

Claims

Pittsburgh Railways Claim Department. Organization, and details of various systems used. 5000 w. Elec Ry Jour—July 24, 1915. No. 62898.

Empty Movement

The Unnecessary Movement of Empty Freight Cars. Committee report of the Gen. Supts. Assn. of Chicago on the proper handling of equipment. 2800 w. Ry Age Gaz—Aug. 13, 1915. No. 63426.

Munitions Shipping

Connecticut to Poland by Way of the Pacific. Henry Harrison Suplee. Map showing route; and explanation. 900 w. Sci Am—Aug. 7, 1915. No. 63153.

Rates

Reductions Ordered in Rates on Anthracite Coal. Revenues may be decreased $8000000. 7000 w. Ry Age Gaz—Aug. 20, 1915. No. 63566.

Decision on Anthracite Rates. Information from I. C. C. report. 4000 w. Ry Rev—Aug. 21, 1915. No. 63554.

Western Railways Get a Small Rate Increase. Advances allowed on coal, coke, fruit and vegetables; denied on grain, livestock and packing house products. 8000 w. Ry Age Gaz—Aug. 13, 1915. No. 63427.

Supplies

Locomotive and Train Supplies on the Frisco. Scheme for handling. Ills. 1200 w. Ry Gaz, Lond—Aug. 6, 1915. No. 63666 A.

War Service

The Battle of the Marne. Account of the wonderful railway service in France. 2500 w. Ry Gaz, Lond—Aug. 13, 1915. No. 63667 A.

MISCELLANY

Locomotive Sparks

Locomotive Sparks. Lawrence W. Wallace. Results of practical tests as to effect in setting fires. Ills. 10 pp. Pro Mas Boil Mak Assoc—1915. No. 63266 N.

North-Eastern Ry.

The North-Eastern Railway, Its Rise and Development. W. M. Acworth. Reviews a book by W. W. Tomlinson. Map & Ills. 2000 w. Ry Gaz, Lond—July 30, 1915. No. 63334 A.

Peru

Mineral Statistics for 1913 (Estadística minera en 1913). Carlos P. Jimenez. Bol Cuer Ing Min Peru—No. 81. No. 63236 N.

Rock Island

The Interstate Commerce's Report on Rock Island. Reviews history and condemns policy of syndicate. 7000 w. Ry Age Gaz—Aug. 20, 1915. No. 63568.

Statistical Records

The Greatest Present Need of Railroads. F. Lincoln Hutchins. Importance of accurate statistical records. 2500 w. Ry Rev—Aug. 7, 1915. No. 63315.

Syria & Palestine

The Railway Lines of Syria and Palestine. Lewis R. Freeman. Résumé of conditions before the war. Ills. 2500 w. Ry Age Gaz—July 30, 1915. No. 62996.

STREET AND ELECTRIC RAILWAYS

Battery Vehicles

Battery Vehicles as an Adjunct to Tramways. W. H. L. Watson. Read before the Tram. & Lgt. Rys. Assn. With discussion. 4500 w. Tram & Ry Wld—Aug. 12, 1915. No. 63663 A.

Cars

Design for the New Trolley Cars of the Vienna Municipal Street Railways (Entwurf für neue Triebwagen der Wiener städtischen Strassenbahnen). Ludwig Spängler. General description. Ills.

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1800 w. E K u B—Aug. 4, 1915. No. 63523 B.

Car Signs

Route Signs for Surface Cars. Novelties in several cities. Ills. 1200 w. Elec Ry Jour—Aug. 14, 1915. No. 63445.

Coasting

Scientific Coasting at Oakland, Calif. Advantages of recorders and results. Ills. 2500 w. Elec Ry Jour—Aug. 14, 1915. No. 63446.

Contact Systems

Contact Conductors and Collectors for Electric Railways. C. J. Hixson. Problem; essential factors for successful ways of attaining results. Ills. 4000 w. Pro Am Inst of Elec Engrs—Aug., 1915. No. 63579 D.

Contact System of the Butte, Anaconda & Pacific Railway. J. B. Cox. Overhead system advisable; reasons for adopting roller pantagraph, etc. Ills. 12000 w. Pro Am Inst of Elec Engrs—Aug., 1915. No. 63578 D.

Denver

Traffic Investigation in Denver. Roger W. Toll. From *The Tramway Bulletin.* Methods used and results obtained. Ills. 4000 w. Elec Trac—Aug., 1913. No. 63559.

Elevated Railways

Stations for Third Track, New York Elevated, Placed Above Existing Platforms. "Hump" construction; express track is raised above local tracks. Ills. 1200 w. Eng Rec—July 31, 1915. No. 63020.

Inspection

Car Service Inspection in Seattle. J. W. McCloy. Methods of checking car loading. 1800 w. Elec Ry Jour—Aug. 14, 1915. No. 63447.

Interurban

London and Port Stanley Railway. A 24.46 mile electric railway operating under Niagara power. Ills. 900 w. Can Engr—July 29, 1915. No. 63026.

The Operation of the Pacific Electric Railway. Study of largest interurban system in the country. Map & Ills. 3300 w. Ry Age Gaz—Aug. 6, 1915. No. 63139.

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Economics of the Jitney Bus Movement. F. W. Doolittle. Abstract from *Jour. Pol. Econ.* Factors affecting development of movement, and conclusions therefrom. 6000 w. Elec Ry Jour—Aug. 7, 1915. No. 63318.

Digest of Jitney Ordinances. Clyde Lyndon King. Details of ordinances for regulation. 2500 w. Elec Ry Jour—Aug. 21, 1915. No. 63600.

London

The Electric Railways of London. Economy resulting from consolidation. Map. 2000 w. Ry Gaz, Lond—Aug. 6, 1915. No. 63664 A.

Railless

Railless Electric Tramways (Sulla trazione elettrica senza rotaie—filovia—). Elvio Soleri. Experience in Italy. Ills. 3000 w. Industria—June 13, 1915. No. 62605 B.

Rails

Girder and High T-Rail Renewals. Exum M. Haas. Summary and discussion of existing practice; rate of wear; derivation of formula. Ills. 4500 w. Elec Ry Jour—July 31, 1915. No. 63032.

Safety

Safety of Trains on the Chicago Elevated. Outlines the organization to secure safe operation. Ills. 3000 w. Elec Ry Jour—Aug. 21, 1915. No. 63598.

Schedules

Operating Cost and Shifts in Service. F. W. Doolittle. Making schedules; cost of rush hour service. 1700 w. Elec Ry Jour—Aug. 21, 1915. No. 63599.

Seattle

Seattle's Traction Muddle. Explanation of troubles. 2500 w. Elec Trac—Aug., 1915. No. 63560.

Shops

Monroe (Tex.) Maintenance Shops. New shops handling both 600-volt city and 1200-volt interurban cars. Ills. 1200 w. Elec Ry Jour—July 31, 1915. No. 63031.

Signaling

New York Municipal Automatic Signals. Light and audible signals in cab, and speed control system on new rapid transit line. Ills. 2000 w. Sig Engr—Aug., 1915. No. 63302.

Small Cars

Economies in Operating Small Cars. J. F. Layng. Advantages of lighter equipment. 4000 w. Gen Elec Rev—Aug., 1915. No. 63055 A.

Stations

Cleveland Builds Four Operating Stations. Superior Ave. station described; reasons for principal features. Ills. 2000 w. Elec Ry Jour—Aug. 28, 1915. No. 63769.

Subways

Subway Ventilation Schemes. Brief descriptions of schemes suggested for New York. Ills. 1400 w. Heat & Vent Mag—Aug., 1915. No. 63730.

New York Subways—Excavation and Concrete. Henry L. Oestreich. Details of work on Section 11-A-3, extending from Tenth to Twenty-seventh St., Brooklyn. Maps & Ills. 5000 w. Brooklyn Engrs' Club. No. 122—1914. No. 63820 N.

BOOK NOTICES

Tracks

Tramway Track Construction and Maintenance. By R. Bickerstaffe Holt. Size, 10 x 6½"; pp. 249. Ills. London: Price, $4.50. Tramway and Railway World.

Principles, good practice, kinks, etc.

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American Electrochemical Society. South Bethlehem.
American Foundrymen's Association. Cleveland.
American Gas Light Journal. *w*. New York.
American Inst. of Architects. *yr*. New York.
Amer. Jour. of Public Health. *m*. New York.
Amer. Jour. of Science. *m*. New Haven.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. d Arch Ital. *s-m*. Rome.
Applied Science. *m*. Toronto.
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Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automobil Rundschau. *s-m*. Berlin.

Beton und Eisen. *s-m*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. New York.
Brickbuilder. *m*. Boston.
Bull. Am. Inst. Mining Engrs. *m*. New York.
Bull. Am. Iron & Steel Inst. *m*. New York.
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Bulletin de la Société d'Encouragement. *m*. Paris.
Bull. Can. Min. Inst. *m*. Montreal.
Bull. Soc. Int. d'Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis. Madison.
Bull. Int. Railway Congress. *m*. Brussels.
Bull. Univ. of Illinois. Urbana, Ill.
Bureau of Mines. Washington.
Bureau of Standards. Washington.

Canadian Engineer. *w*. Toronto and Montreal.
Canadian Mining Journal. *b-w*. Toronto.
Chem. Met. Min. Soc. S. Af. *m*. Johannesburg.
Coal Age. *w*. New York.
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Colliery Guardian. *w*. London.
Commercial Vehicle. *s-m*. New York.
Commonwealth Engineer. *m*. Melbourne.
Compressed Air. *m*. New York.
Concrete-Cement Age. *m*. Chicago.
Cornell Civil Engineer. *m*. Ithaca.

Dept. of Agri. Washington.

Economic Geology. *s-q*. New Haven.
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Electric Traction. *m*. Chicago.
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Elektrische Kraftbetriebe u Bahnen. *w*. Munich.
Elektrochemische Zeitschrift. *m*. Berlin.
Elektrotechnik u Maschinenbau. *w*. Vienna.
Elektrotechnische Rundschau. *w*. Potsdam.
Engineer. *w*. London.
Engineering. *w*. London.
Engineering and Contracting. *w*. Chicago.
Engineering Contractor. *m*. New York.
Engineering Magazine. *m*. New York and London.
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Eng. Soc. of Western Penn. *m*. Pittsburgh.

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Feuerungstechnik. *s-m.* Leipzig.
Foundry. *m.* Cleveland, Ohio.

Gas Age, *b-m.* New York.
General Electric Review. *m.* Schenectady.
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Geological Survey. Washington.
Giesserei-Zeitung, *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
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Horseless Age. *w.* New York.

Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Turin.
Industria. *w.* Milan.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trade Review. *w.* London.
Iron Trade Review. *w.* Cleveland, Ohio.

Jour. of Accountancy. *m.* New York.
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Jour. Am. Soc. Heat. & Vent. Engrs. *qr.* N. Y.
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Journal Franklin Institute. *m.* Philadelphia.
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Jour. of Worcester Poly Inst. Worcester, Mass.

La Nature. *w.* Paris.

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Marine Engr. and Naval Archt. *m.* London.
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Mining Journal. *w.* London.
Mining Magazine. *m.* London.
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Practical Engineer. *s-m.* Chicago.
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Pro. Lake Superior Min. Inst. Ishpeming.
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Pro. Railway Club of Pittsburgh. *m.* Pittsburgh.
Pro. St. Louis Railway Club. *m.* St. Louis.
Pro. U. S. Naval Inst. *qr.* Annapolis.
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Railway Master Mechanic. *m.* New York.
Railway Review. *w.* Chicago.
Revista Marittima. *m.* Rome.
Rev. d'Electrochimie et d'Electrométall. *m.* Paris.
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Safety Engng. *m.* New York.
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Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
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Travelers Standard. *m.* Hartford.

Werkzeugmaschine. *b-m.* Berlin.
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Zeitschr. f. d. gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Ver. deutscher Ing. *w.* Berlin.

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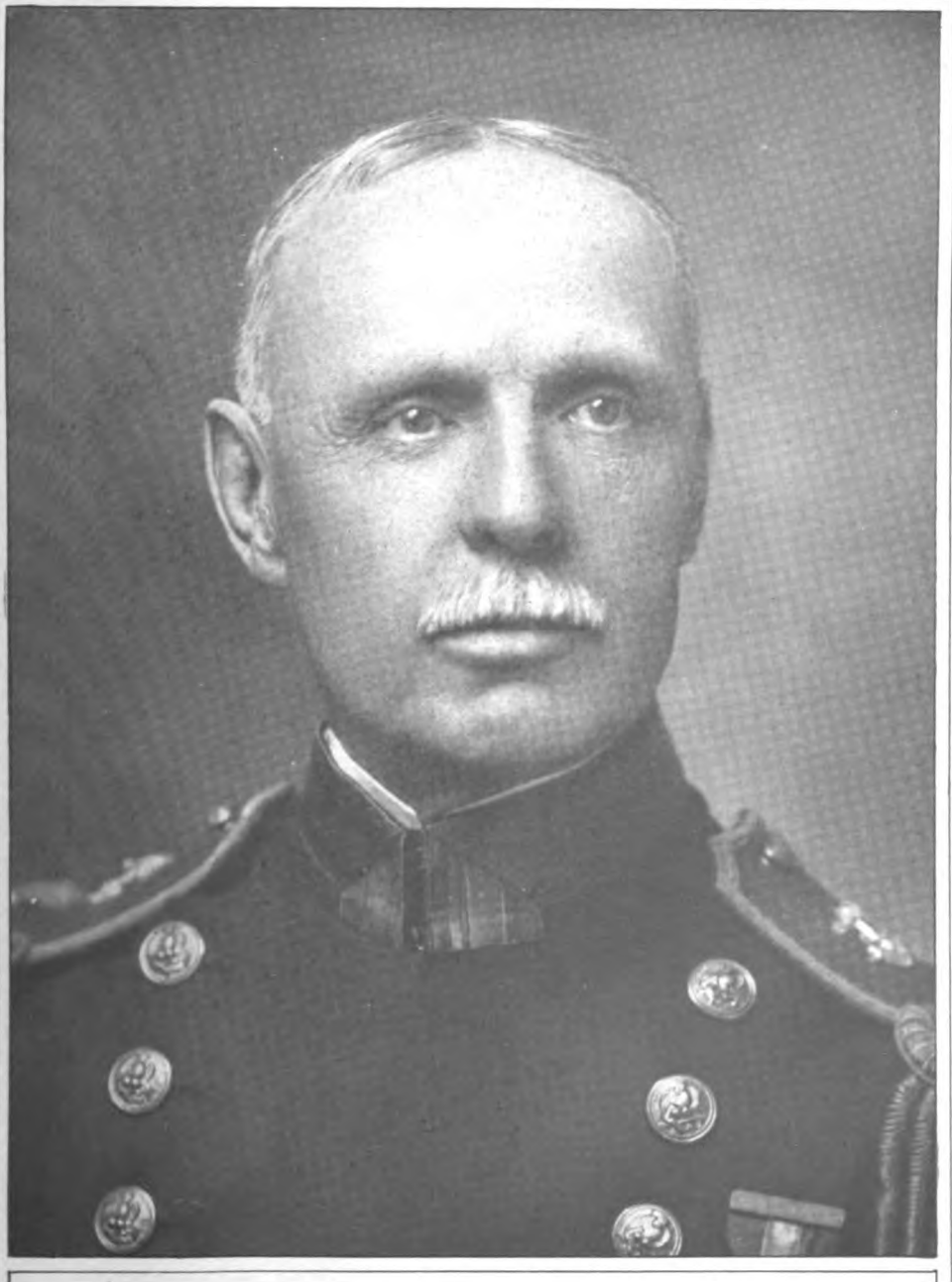

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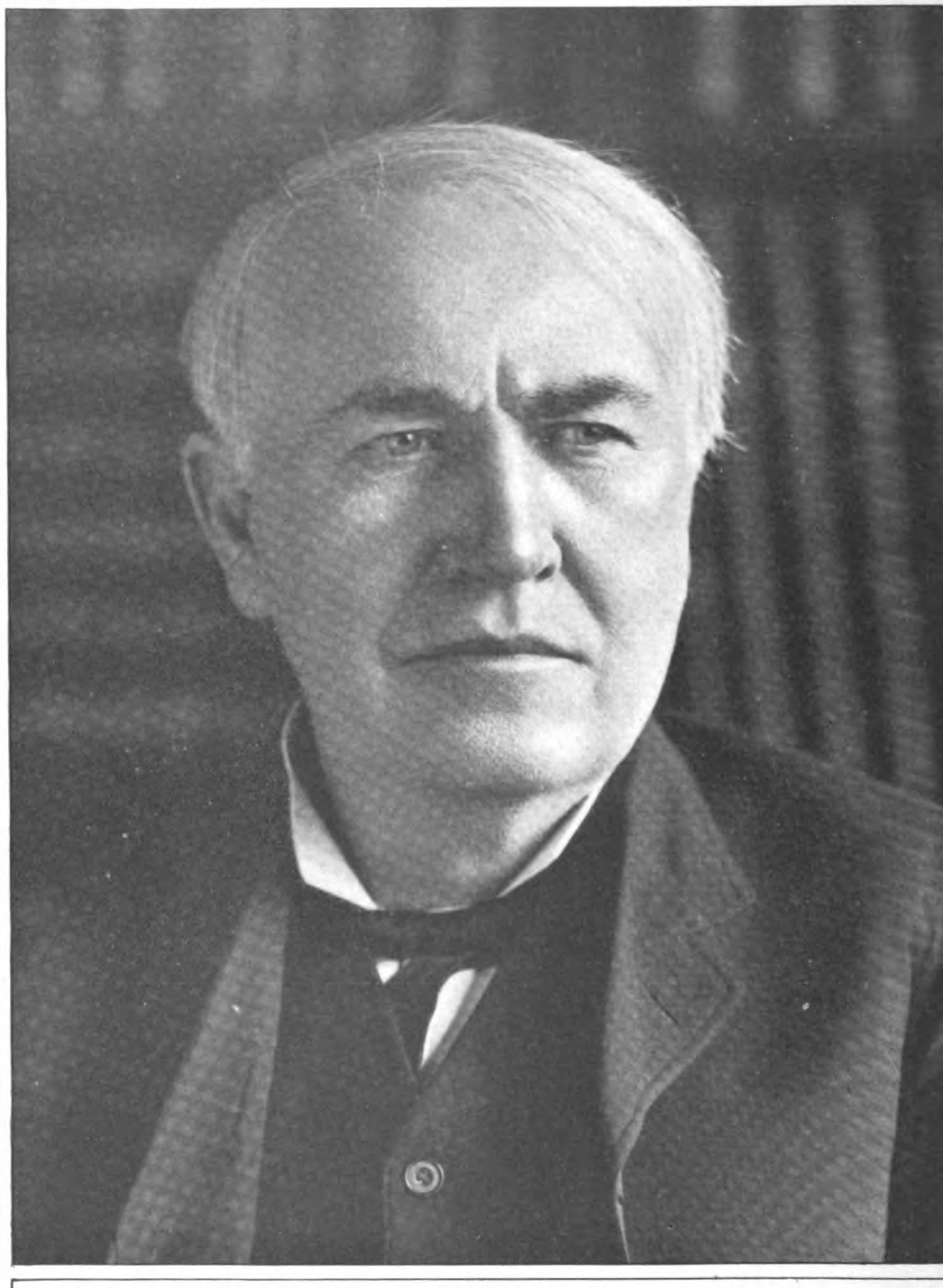

THOMAS ALVA EDISON

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THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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FOR PEACE AND PROSPERITY WITH A FIGHTING NAVY TO PROTECT THEM

By the Editor

THE Germans so dearly love their Kaiser, the Austrians so reverence their dear old Emperor, and all the English so "dearly love a lord," that, in now writing about our navy, I suppose I should be very careful about offending the patriotic sensibilities of these and other foreigners.

But I know something of the history, exploits, and fighting fibre of the American Navy in the past; even schoolboys of today remember what Dewey did at Manila, and every naval Lord in all Europe took due notice of that second Fourth of July declaration which came up from Santiago in 1898. For these reasons, I now feel very much as "Fighting Bob" Evans felt when, as Admiral of the Fleet, he sailed around the world a few years ago to visit all the foreigners, including the watchful and observing Japanese. At that time many timid people had been frightened into the belief that war was imminent. But "Fighting Bob" did not seem to think so—and at any rate he didn't care! For, just before he sailed, the Lotos Club of New York tendered him a very handsome farewell dinner, and I had the good luck to be there. Never in all my life have I listened to a wittier, more

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patriotic, and more confident after-dinner speech, and the climax came when "Fighting Bob," chuckling with gutteral laughter, said this: "We are off for a frolic or a fight—and I don't care a damn which."

So, in writing about our navy, which is our own affair, I shall now write precisely what I think—and not concern myself about the sorry plight of the few hyphenated gentlemen in our midst who have not yet waked up to the priceless privilege of American citizenship.

> "Some of the best stuff of America has come out of foreign lands, and some of the best stuff in America is in the men who are naturalized citizens of the United States. I would not be afraid, upon the test of 'America first,' to take a census of all the foreign-born citizens of the United States, for I know that the vast majority of them came here because they believed in America, and their belief in America has made them better citizens than some people who were born in America.
>
> I am not deceived as to the balance of opinion among the foreign-born citizens of the United States, but I am in a hurry to have an opportunity to have a line-up, and let the men who are thinking first of other countries stand on one side—Biblically, it should be the left—and all those that are for America first, last, and all the time, on the other side."
>
> —*President Woodrow Wilson.*

The upbuilding of our navy is so vital an issue, the "peace-at-any-price" dreamers are so vocal, and so few people seem to be awake to the far-reaching significance of the appointment of a distinguished body of civilian engineers to coöperate with the engineer officers of the navy in the important work to be done, that I think I can now clarify the situation by presenting, very briefly, historic evidence to prove that *MILITARY RULE*—that, and that alone—is precisely what has plunged all Europe into the most awful war of all time.

The literature of our Revolutionary Era, especially its biographies, its pamphlets, and its intimate personal letters, has been the absorbing study of my life—my never-failing pastime and recreation. Naturally enough, I have made a close study of the European history leading up to the American Revolution, and this, concisely, is what I have learned:

It was Julius Cæsar, with his legions, who first conquered Gaul, then conquered Rome itself, then conquered nearly the whole of Europe, and then Asia besides. And

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Cæsar's military and civil rule was so supremely great that his successors, with the aid of the Roman armies, ruled the vast Roman Empire brilliantly through five centuries of time—and then plunged all Europe back into barbarism and the Dark Ages!

The first bright rays of light and liberty of thought came with John Wycliffe's preaching (1320-1384), and his translation of the Bible into the English language. John Huss, the Christ-like Bohemian, followed Wycliffe in the next generation (1373-1415)—and was promptly *burned at the stake* at the early age of forty-two. A century later Martin Luther (1483-1546), the greatest of all the Germans, did his grand work, for the time was ripe and he *forced* the Reformation. Then, with the seventeenth century, came Oliver Cromwell (1599-1658), the grim old Christian soldier who rescued England from autocratic rule, became Protector of the Commonwealth, and immortalized both his name and his work by putting a tyrant king to the block. But old Oliver was no sooner laid away than King Charles II, son of the beheaded king, was promptly restored to power—and proceeded forthwith to make himself notorious in history for the extravagance and profligacy of his pleasure-seeking reign.

The change of rulers, and reaction from the puritanic regulations which Cromwell had enforced upon everybody, made grave trouble for his followers, and straightway the Puritans were so ostracized and persecuted that thousands fled the country. But they had the sympathy of other liberal-minded Christians, and a few years later, when King James II, an avowed Roman Catholic, came to the throne, the conflict between the Protestants and Catholics became so fierce that in 1688 James was actually driven from the throne. He fled across the channel and found welcome refuge at the court of "The Grand Monarch," Louis XIV of France, who proudly boasted, "I am the State"—and that he was in fact. But old Louis little knew that throughout all his long and "splendid" reign, while he was wasting the substance of the French people in vain show, free men everywhere were manufacturing the liberty-loving dynamite which exploded in France in 1789.

When the "Terror" burst over Paris, it was an obscure and poverty-stricken lieutenant in the French army, Na-

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poleon Bonaparte—the incarnation of military genius, murderous warfare, and insatiable ambition—who suddenly sprang to the front, grasped the sceptre of power, restored order at home, conquered first one and then another of the feeble monarchs nearest at hand, and, for a very brief period, actually dominated nearly all of Continental Europe. But his splendid splurge was ended at Waterloo—and then came St. Helena!

> "No man on earth has stronger detestation of the unprincipled tyrant Bonaparte than myself.
>
> "What suffering can atone for his crimes against the liberties and happiness of the human race; for the miseries he has already inflicted on his own generation, and on those yet to come, on whom he has riveted the chains of despotism."
>
> —*Thomas Jefferson.*

Little more than a generation later, one of Bonaparte's nephews—"Napoleon the Little," as Victor Hugo rightly named him—suddenly fascinated the French people with a popular vote so overwhelmingly in his favor that he also became emperor. But his weak head soon tricked him into the War of 1870—and now we have the sequel!

The Emperors, the Kings, the Czars, and the Princes—with their miserable entourage of scheming diplomats and traitorous spies—have plunged all Europe into a holocaust of war, the most frightful of all recorded history! And thus, for the last time, let us hope, we plainly see that "military rule" is the curse of Europe today—precisely as it has been the curse of Europe throughout all historic time!

> "Sometimes it is said that man cannot be trusted with the government of himself.
>
> "Can he then be trusted with the government of others?
>
> "Or have we found angels in the form of kings to govern him?
>
> "Let history answer this question."
>
> —*Thomas Jefferson.*

It is needless to review our Revolutionary struggle—because every man and woman born in America learned the essentials of the story at school. But I am sure it will rekindle patriotism if I give one brief quotation from Turgot—the foremost constructive statesman in all the history of France! Reading aright the uplifting language of our Declaration of Independence, and intently watching Washington's strategy and early battles of the Revolutionary War, in 1778 it was Turgot who wrote this:

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> "It is impossible not to offer vows that this people may arrive at all the prosperity of which it is susceptible. It is the hope of the human race. It can become its model. It must prove to the world, by the fact, that men can be free and tranquil, and can dispense with the chains of all kinds which tyrants and *charlatans of every cloth* have pretended to impose *under the pretext of public good*. It must give the example of political liberty, of religious liberty, of commercial and industrial liberty. The asylum which it opens to the oppressed of all nations must console the earth. The facility it affords for escape from a bad government will force the European governments to be just and enlightened."

And I am sure, also, that one brief quotation, from a great Anglo-Saxon statesman, will drive home to the comprehension of many thoughtless Americans the priceless character of the free institutions which we are now called upon to guard, to protect, and to preserve, for ourselves and for future generations.

It was William Ewart Gladstone, the profound student of world history, and one of the foremost of all British Liberal statesmen, who, near the close of his long and brilliant career, wrote this:

> "The Constitution of the United States is the most wonderful work ever struck off at a given time by the brain and purpose of man."

In this Constitution, thus accurately described, the "embattled farmers" who won us independence from the military rule of British armies and navies, took very careful pains to specifically provide that the President of the United States, a *civil* officer elected by the votes of the people, should be the *Commander-in-Chief* of both our Army and our Navy. And, second in command, appointed by the Commander-in-Chief, are *civilians* in full official authority over both the Army and the Navy.

Following the lead of the organic law of the Nation, the Constitution of every state in this broad union, with the notable exception of New York State, specifically provides that *"the military shall be forever subordinate to the civil power."*

"But what has all this to do with engineering?"

That is a silly question which has been thrown at me with such startling frequency in recent weeks that now I shall answer very definitely—for if there be one thing more important than all others right now, it is that engineers

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and business men shall be immediately aroused to a clear understanding of the unbreakable link which binds all commerce and industry to the organic laws of our Nation.

Unless the Nation be rightly *constituted,* and rightly *ruled,* normal and healthful business conditions are not possible—as witness the desperate commercial and industrial disaster which has suddenly overwhelmed innocent individuals and personal and corporate business of every kind throughout Europe, because of this uncalled-for war.

On the other hand, to show how absolutely dependent are the war lords themselves upon the genius and creative power of truly great men whose lives are devoted to peaceful industry, let me cite this array of historic facts:

Gun-powder was re-discovered and applied to military uses by the chemists of Italy, France, Germany and England, between 1326 and 1344. The Germans and the English have always been at war as to whether Berthold Schwartz, the German monk, or Roger Bacon, the English Friar, is entitled to most of the credit: and this time, no doubt, they will fight the controversy to a finish.

But there is no manner of doubt that James Watt invented the condensing steam engine; that Robert Fulton developed and demonstrated the steamboat; that John Ericsson invented the screw propeller; that Samuel F. B. Morse invented the electric telegraph; that Alexander Graham Bell invented the telephone; that Hiram Stevens Maxim (not Hudson, who is a younger brother) invented the automatic machine gun; that John P. Holland developed and demonstrated the submarine; that Guglielmo Marconi invented wireless telegraphy; that the Wright Brothers developed and demonstrated the aeroplane; and, finally, that Henry Ford has done more than any other living man to bring the automobile, and its gas engine, into universal use. All of these were civilian engineers—because Captain Ericsson retired from the Swedish army ten years before he invented the screw propeller.

Thus we see that every implement of modern warfare, from a battleship to an aeroplane and motor-truck, is the creation of men who have devoted their lives to peaceful pursuits.

It is, in truth, the inventors and engineers who have revolutionized industry, who have annihilated distance, who

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have made the world a neighborhood, and who will yet emancipate our people from poverty and all fear of dependence upon charity, if we but prudently guard our free institutions—for men's minds are only beginning to awake to *the infinite wealth-producing power* of automatic machinery and mechanical power.

Now, for the first time in all our military history a Secretary of the Navy, Hon. Josephus Daniels, has formally appointed a distinguished body of civilian engineers and inventors as a Naval Consulting Board, and has asked them to give him the benefit of their best brains and advice in upbuilding the American Navy—and instead of making them personal selections, he has eagerly and gladly appointed those selected by the eleven foremost engineering and scientific societies in the United States—regardless of partisan politics.

This means that the brains, the patriotism, the organizing capacity, and all the vast manufacturing resources of our blessed country are now mobilized and united for defense! And it is fact, of weighty significance, that the grave controversy with Germany over her submarine warfare, lasting for months of time, came to a final settlement almost simultaneously with the first meeting of this Naval Consulting Board.*

We already have a vast and rapidly expanding foreign trade, which is certain to be at the mercy of the victors in this war—because they will command the seas!

> *RESOLVED*, that the Board of Directors of the National Association of Manufacturers (3,500 members) express its conviction that the question of national defense is of the highest importance to the United States, and that as shown by the official reports of cabinet officers and the testimony of army and navy experts adequate national defense has not received in the past the serious consideration which it deserves.

Then we have the grim reality of the Monroe Doctrine—with war still on in Mexico, with revolutionary ferment active throughout Central America, with the locks of the Panama Canal liable to be blown up at any moment as a means of dividing our naval forces, or the Canal itself liable to capture by a formidable European fleet—and *all* South America, undefended save by ourselves, offers a most tempting field for conquest, colonization, and Empire building.

* See Editorial Comment page 301.

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Here in our home waters we also have Cuba and Porto Rico which we *must* defend, and far out in the Pacific are both Hawaii and the Philippines—thousands of miles away!

Surely further argument is needless—surely every sane man must now see that the imperative duty of this hour is to build up Liberty's *surest* defense!

> "It is vain, sir to extenuate the matter. Gentlemen may cry peace, peace, but there is no peace. The war is actually begun. The next gale that sweeps from the north will bring to our ears the clash of resounding arms. Our brethren are already in the field. Why stand we here idle? What is it that gentlemen wish? What would they have? Is life so dear, or peace so sweet, as to be purchased at the price of chains and slavery? Forbid it, Almighty God! I know not what course others may take, but as for me, give me liberty, or give me death!"
>
> —*Patrick Henry in the Virginia Convention, March,* 1775.

> "It is for us, the living, rather to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us, that from these honored dead we take increased devotion to that cause for which they gave the last measure of devotion—that we here highly resolve that these dead shall not have died in vain—that this Nation under God shall have a new birth of freedom—and that GOVERNMENT OF THE PEOPLE BY THE PEOPLE AND FOR THE PEOPLE shall not perish from the earth."
>
> —*Lincoln at Gettysburg.*

WE WANT FREEDOM OF THE SEAS—AND WE MEAN TO HAVE IT!

WE WANT FREEDOM FROM ALL MENACE OF MILITARY RULE—AND WE MEAN TO HAVE IT!

WE WANT A FIGHTING NAVY WHICH CAN CHALLENGE THE BRAVEST DEEDS OF DEWEY, OF FARRAGUT, AND OF JOHN PAUL JONES—AND WE MEAN TO HAVE IT!

WE WANT BOTH PEACE AND PROSPERITY—AND WE MEAN TO PRESERVE AND ENJOY THEM BOTH!

New York, October 29th, 1915. JOHN R. DUNLAP.

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THE PART OF THE CIVILIAN ENGINEER IN NAVAL PREPARDNESS

By Frank J. Sprague

Graduate of Annapolis, and Member of the Naval Consulting Board

A QUERY as to his possible usefulness is a natural one in view of the recent action of the Secretary of the Navy in summoning to his aid the civilian body of engineers known as the Naval Consulting Board, and by engineer I mean to include the inventor, whose effectiveness is largely dependent upon whether he is also a trained engineer.

When the Secretary determined upon the creation of such a body, there was initiated, almost simultaneously with like action by the British Government, a new and important move for mobilizing and making use of the country's latent fund of inventive, engineering and manufacturing talent and equipment. But compared with the British procedure a radical departure was made. Personally largely unfamiliar with the scientific reputation and attainments of the inventors and engineers in the various fields of science, and unable to surrender to others with even less detail knowledge a decision of so vital a character in regard to membership, Secretary Daniels called to his aid the presidents of various national engineering societies, which comprise in their membership a large majority of the creators of the industrial fabric of the country. When he asked them to submit nominees for his consideration he took a unique, and in fact the most advanced step of its kind ever taken by a public official, the result of which, if the results sought for are attained, will be far-reaching in its consequences.

It is not necessary to assume that its composition is beyond criticism, but a vital principle has been established in that the engineering profession has been recognized by a popular government in a generous spirit. Its members have been selected to represent the societies to which they belong, and the nominations were made and accepted without any pressure whatever, and likewise without regard to political affiliations.

With this action there has not only been made a new effort to increase the efficiency of government expenditures and aid the up-building of a most important department, but there has been rendered the engineering profession and those that represent it a most signal honor. But the creation of the Board, no matter how eminent its membership, does not of itself insure effective results; to warrant that creation the members must likewise justify their individual nominations to it. Coming from various walks in professional life, they are, despite the fact that a few have had naval training, essentially civilians, and know little of the profession of arms and of a great technical and professional organization, manned by officers carefully educated by the Government at great expense and representative to the last degree of the best democracy

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of this country. In the technique of their profession outsiders can teach them little or nothing. They can only hope to bring some aid from those fields of engineering endeavors with which they are affiliated, for although many features of naval equipment have been initiated, developed and manufactured outside of the Navy, the fact remains that to pass with a reasonable measure of intelligence on matters pertaining to their profession a fairly intimate acquaintance with officers and crew, ships and their fighting equipment is essential. It follows that there must be a sympathetic understanding with the real needs of the Service and the difficulties incurred in solving special problems.

Much hasty and ill advised comment has been indulged in as to what this Board can do. It has no authority whatever in law, is not in the actual employ of the Government and no executive function can be delegated to it. Its members receive no financial remuneration for their services, and meet their own travelling expenses, thus preserving an enviable independence.

But those whom the government has taught are thoroughly capable of command, having acquired the rudiments of their profession in an unsurpassed institution, the Naval Academy of Annapolis, and the school of experience has widened their conceptions and their capacity. Their business is the preparation for fighting, and they must be the ultimate judges of what is useful and material to that end. The war which is now raging will determine, in a large measure, the value of many a weapon of offense or means for defense on land and sea, and the immediate problem will be the selection of devices already being tried out. But failures of various kinds will indicate the need of new aids, and in co-operative work inside and outside of the Service there lies the possibility of material advance.

Every war proves an occasion for a renaissance of Keelyism, and thousands of so-called inventions are born with stalwart but inarticulate cries. The majority die an early death, but some deserving ones for lack of nourishment, for the motive power back of most inventions is the hope of reward. In the majority of cases it is the hope of financial return, not alone to the inventor but to those who provide the sinews of war to carry an invention to success, but in many cases personal recognition and the satisfaction derived from successful accomplishment is sufficient.

The regular training of a naval officer tends to make him analytical, and in the ordinary course of his duties his time is well occupied in making regular use of what has been entrusted to his hands and maintaining it in a suitable state of efficiency. Yet within the Service there are many men of exceptional creative and engineering capacity who if given but fair opportunity will produce inventions of the highest importance. Happily, in spite of all difficulties magnificent work is being steadily carried on under the direction of the various Bureaus and at the various navy yards, under competent management, but lack of appropriation as well as meagreness of facilities are still well recognized handicaps for insuring the maximum of achievement, and civilian aid seems essential to the best results.

The determination of the originality and value of inventions which may be offered to the Navy is one of the most important and thankless of tasks. No matter what one's technical equipment and experience may be, sad experience proves how diffi-

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cult, often impossible, it is to pass upon the merits of untried inventions, how prone one is to error when expressing judgment upon the works of others, whether from a lack of understanding, or because of failures of one's own which may have resulted in a prejudicial bias. Then, too, experience has demonstrated the futility of most inventions, and the long and thorny road over which one must travel even when success is the final goal.

As it has been announced, the Naval Consulting Board recently met for organization at Washington, and determined, in consultation with the Navy Department, the subject heads to be dealt with by various committees, also the method of selection of these and the routine treatment of all matters which should come before the Board or its individual members. By adopting this procedure provision was made for those best qualified in certain lines to concentrate their efforts and experience where they can be most effective, while at the same time being aided by the opinion of all.

As a typical example, one may consider the possible usefulness of a committee dealing with aeronautics, with special reference to motors used therein, for here a lesson can be taken from the splendid success which has attended the efforts of the men prominent in the automobile industry, for the elimination of unnecessary parts, standardizing of specifications for material and cheapening of manufacture. An active committee dealing with this problem would not be confined to the knowledge and experience of its individual members, but because of their wide professional and business associations and their knowledge of men and processes they would be able to call upon the best talent in the country for advice. If properly supported they would be able to develop the highest type of a standardized aeroplane motor which could be built by a score of manufacturers, with a degree of reliability and at a cost bearing little comparison to the existing products. I have suggested in a brief way what might be done in one field, one in which there is most urgent need, but similar activities can be inaugurated in many other lines.

But where material expense is involved, and such is always required in every development, the Government must be prepared to assume the responsibility of carrying out concrete recommendations. To that end the Board has advised the establishment of a great Naval Research Laboratory and Experimental Station, which may ultimately represent an investment of five million dollars, and cost one half as much annually to maintain. Of course, neither of these figures represent present requirements, but simply the judgment of the Board as to probable finals. Leaving out the question of land purchase, which might or might not be necessary, the first year's requirements for buildings and equipment, to be expended under the direction of the Secretary of the Navy after detailed plans have been approved, would probably not be over $1,000,000 and the first active year's allowance for organization and operation $500,000.

Before this recommendation was made the Board was supplied with a complete statement of the facilities of the Department, and some personal investigations had already been undertaken, which made it clear that if the Navy is to be maintained at the standard of highest efficiency, and the great expenditures demanded for preparedness are to be safe-guarded, the National Government must be put in a position to carry on research and

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experimental work in the most effective manner.

It should be pointed out that there is no intention to interfere with, or improperly encroach upon the province of the several admirable existing experimental plants, or the functions of such a splendid institution as the Bureau of Standards in Washington, whose prime duty is the establishment of standards but which has now widened its sphere so that it is carrying on research work of the highest order. But every man active in the mechanical arts knows that, in addition to the essential patient and invaluable research, it is often imperative to conduct on a large and costly scale practical tests of apparatus, because the time saved at critical periods often justifies what might at first glance appear excessive expediture.

While the purpose for which the Board was created has been somewhat definitely stated, it would seem that if its present activities are confined to a consideration of the merit of such inventions as may, after having been properly sifted out, be referred to it, or which may originate among its members or their associated interests, its usefulness would be unnecessarily restricted.

Therefore, although foreign to the reasons for its conception, it is quite possible that the Naval Consulting Board may prove of use in quite another direction. Being a non-Service and non-political body, serving without compensation, they are as far as possible removed from the suggestion of self-interest in the augmentation of naval and military establishments. They form a tax-paying connecting professional link between the trained fighter and the civilian who provides the sinews of war, and as such ought to be in a position to express, without undue prejudice and up to the limit of their knowledge and capacity, their conviction on any related subjects.

It is quite conceivable, therefore, that their individual opinions might be acceptable and perhaps influential under some exigencies; but to what extent the Board members should at any time be concerned in advocating a specific program of naval preparedness will necessarily be a matter of individual determination. In any case, the needs of the whole country, uninfluenced by politics or sectional prejudice, would be a *sine-qua-non.*

Rear Admiral Goodrich closes a recent article on "The Future of the Battleship" with the following words: "To Americans it must be an interesting reflection that the present battles for supremacy in the air and beneath the surface of the water are based upon the inventions of their countrymen, Bushnell, Holland and Wright." I may add the hope and conviction that American inventors and engineers will remain in the forefront of every effective development essential to the defence of the priceless heritage committed to the care of the country's defenders.

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SHIPS AND A NAVY FOR THE AMERICAS

By William L. Saunders

Vice Chairman of the Naval Consulting Board, and President of the American Institute of Mining Engineers

MY colleague, Mr. Sprague, of the Naval Consulting Board, has covered the theory, functions and possibilities of this newest creation in our naval organization so thoroughly, that I can well afford to turn my attention to another and a vital phase of our naval and commercial policy—the present and imperative need of "Ships and a Navy for the Americas."

But before discussing this phase of the subject, I am prompted to offer a few words of explanation in correction of mistaken newspaper comment which I have observed in the daily press.

The recommendation of the Naval Consulting Board that a physical laboratory be established on tide water for the conduct of experiments by the Government, seems to have been misunderstood. It is not true that it is proposed that such a laboratory should be under the direction of the civilian board. On the contrary it is to be controlled and directed by the United States Naval officers.

It is not true that the civilian board, or any other board of inventors, is expected to go within the walls of this experimental station and invent or produce devices for the use of the navy. The proposition is that this shall be a great physical work shop for the purpose of trying out and developing inventions which have been submitted from all sources to the United States Government. When such inventions are submitted and are first passed upon by the regular naval engineers it is proposed to submit them, or some of them, to the civilian consulting board for advice and information, and when such advice is received by the naval engineers, and they elect to go further into the suggestions made, then the physical laboratory will be a means by which it may be determined whether or not an invention is a practical one.

The Naval Consulting Board is, as its name implies, a board of consulting engineers and not necessarily a board of inventors. They are not expected to originate plans and practices to any greater extent than all the people of the United States are expected to do so. Their position is identical with that of any other individual in the United States who might have a suggestion to put before the Government, the difference being that in the case of the Consulting Board they may be called upon by the naval engineers to express their opinion, to give advice and perhaps personal assistance, in the development of ideas.

The members of the Naval Consulting Board are responsible to no one except to the societies which elected them. They are in no way Government employees or officers. They receive no compensation from any source and they pay their own expenses.

The United States Government has now two large and many smaller experimental stations. The principal

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one is the Bureau of Standards at Washington, under the Department of Commerce, where a great deal of scientific work is being done in the nature of research and investigation. There is also the Bureau of Mines, where research and experimental work is conducted in metallurgy and chemistry. At various navy yards in the country there are experimental stations, but at no place is there a plant at tide water where actual physical work may be done in the way of building machines on a large scale for the purpose of demonstrating to the satisfaction of the United States naval officers whether or not an advance may be made in naval practice. Such a station is no small affair, for to be of real value it should be so equipped as to reach results expeditiously and thoroughly. In other words, it should do for the Government what Edison's laboratory has done for science and what the General Electric Laboratory has done for that company.

Experimental or development work is necessarily expensive, but our experience in the past would seem to warrant us in believing that it is better to spend money in trying out and perfecting devices for naval service rather than to depend upon the natural course of events during which developments take place slowly through other sources, and in the end individuals or other nations get the benefits that might accrue to this Government. We have only to cite two recent cases of importance—the submarine and the aeroplane—to realize that the American navy would have been far more advanced had the Government taken up through its own physical station the early inventions of Holland and the Wrights. It is work of this kind that can best be done through a large and well equipped physical laboratory under the control of the Government. The man who has had more experience in this line than any other and has achieved a greater success is undoubtedly Mr. Edison. The proposed plan for this research station is his. His greatest work has been acquired through research and experiment. Before he invented the storage battery he tried more than ten thousand experiments, always aiming at a certain result, which he finally achieved. The General Electric Company have found it of the utmost value to spend hundreds of thousands of dollars in research work. It has paid to do it, and why should we hesitate to follow the same lines in protecting and strengthening the greatest and richest of nations? The proposed physical research laboratory, even at the maximum figures placed by Mr. Edison—five million dollars, represents only about one-third the cost of a large battleship. Is it not best to first make sure that we are building this ship right, and in advance of the practice of other nations, rather than plunge forward at large expense and in the end discover costly mistakes? America has long been the birth place of the greatest inventions. Let us utilize this creative force in increasing the safety, strength and efficiency of the nation.

DURING the construction of the Panama Canal the American Institute of Mining Engineers visited the Isthmus. At the city of Panama we were invited to attend a reception at the palace of President Arosemena of the Panama Republic. While the reception was going on the sound of music was heard in the streets and the President turning to several of us who were standing by his side said that he had promised to review the Panamanian troops at four o'clock and

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would now go out on the balcony for that purpose, asking us to be good enough to excuse him for a few minutes. We requested the privilege of accompanying him, which he granted, and were soon standing upon the balcony witnessing the President bowing to a company of seventy-two men in uniform and armed. We asked the President if this was the army of the Panama Republic. He said yes, that they had about sixty more at Colon, "but," said he, turning to us, "this is only our police force; we have no need of an army, for you protect us." He added, with great earnestness, that the situation was a most valuable and satisfactory one to him as President of the Republic in that if any one should attack them from without, or should a serious disturbance arise within the Republic, it was simply necessary to call upon the American troops for safety and protection. "This," he said, "not only insures permanent peace in my country, but it enables me to utilize the money which a standing army would cost for internal improvements such as schools and for many other public benefits."

Similar conditions exist in relation to the Republic of Cuba, and the policy has recently extended to Hayti and to some extent to Nicaragua. The only reason why this wholesome influence for peace and protection has not been more general in Central and South America is because of the lack of confidence that exists there in the motives of the American Government. If it were understood and firmly believed that the United States would maintain forever the policy announced by President Wilson at Mobile, that no territory would be acquired by conquest, there would follow a natural disposition on the part of these struggling, and ofttimes much agitated, republics, to welcome the strong arm of protection which the United States can well afford to give them.

We owe a duty to the Americas. We have undertaken to establish the Monroe Doctrine and to interpret it for their protection as well as our own. In all these years since this Doctrine was announced we have done little or nothing to convince the Latin-American countries that the people of the United States seek their sympathy and cooperation. We have to a certain extent kept aloof from them,—not that we desired to do so, but because we have been more or less ignorant of their conditions, due mainly to a lack of acquaintance. There has been no sympathetic relations between the people of the United States and the Latin-American countries. We have been busy with our own affairs and have extended our interests to Europe while the Europeans have cultivated business relations with Latin-America. In other words, people who speak different languages and are accustomed to different environments must mix and get acquainted before they can inspire confidence in each other. The best way to get acquainted with the Latin-American people is to do business with them, and the first requisite is ships, making frequent and fast sailings, with good passenger service and moderate freight rates. Then follows banking facilities, which have already been partially attained by the establishment of branch banks.

In our efforts to create a merchant marine we might well afford to try the experiment among the Americas, confining our first efforts and bending our best energies there. The people of the United States might acquiesce more readily in an experiment of Government ownership of vessels if the trial is made on a moderate scale

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and on our own continent. We might well afford to spend millions of dollars in doing our duty to the Americas and at the same time building the foundation of commercial intercourse, which is sure to follow, and for which venture the time would now seem to be ripe. While Europe is at war the money and the ships from foreign ports cannot be as energetically bestowed in Latin-American trade as has been the practice in the past. Let us take advantage of the opportunity and spend money in this field which is now open to us and at the same time we shall gain experience which might fit us to more thoroughly and permanently establish a merchant marine. For this purpose the Panama Steamship Line is at our service. Here is an organization owned and controlled by the Government which has had an experience of about ten years and which in that time has accumulated assets amounting to more than twenty millions of dollars; several ships are available and more might be obtained. The charter should be either cancelled and a new Government charter taken out or its privileges enlarged through the legislature which granted it. This Line is directed by a board of experienced shipping men, with General Goethals at the head. He, while not a man of marine experience, is nevertheless an executive of the highest order and his direction would inspire confidence.

If we are to continue our beneficent policy toward the Latin-American countries we must also recognize the necessity for having a large navy. So long as we maintain armaments for defense, and so long as our motives are not selfish, the navy will act as a police force to aid in inspiring confidence and in enforcing peace. These Latin-American countries can ill afford to build up large navies. It is plain that a navy of moderate proportions is at the mercy of dreadnoughts, and dreadnoughts are so expensive that only the United States on this continent can afford to maintain them. If our policy of protection to Latin-American countries is to be a real one we can find no greater use for a large navy than in extending that protection to our brothers to the south of us, always with the assurance that the chief purpose which justifies the expense is the maintenance of peace and for the integrity of all the countries on the American continent.

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OUR NAVAL DEVELOPMENT AS RELATED TO NATIONAL DEFENSE

IMPORTANT AND FAR-REACHING CONSTRUCTIVE WORK DONE BY SECRETARY DANIELS

By Rear Admiral John R. Edwards, U. S. N. (Ret.)

Contrary to frequently published views, the navy department of this Government is a highly efficient organization. The present Secretary, Mr. Daniels, carries nothing but the highest motives to his work. The fact that the Admiral of the Navy, George Dewey, together with the ablest of our Rear Admirals, as well as other high naval officers, speak nothing but in thoughtful praise of the Secretary and his work, should go far toward convincing the public of the absence of veracity in most of the published criticisms.—THE EDITORS.

WITH each succeeding day, there comes accumulative and unmistakable evidence that the problem of formulating an adequate and well-rounded plan of national defense will be one of the most important questions that will be thoughtfully and extendedly considered at the First Session of the Sixty-Fourth Congress.

While it is the earnest hope and expectation of the Nation that some comprehensive and enduring plan for promoting national safety will be enacted into law at the earliest practicable day, the fact is forcibly recognized that the general trend of legislation possible may be materially gauged by the nature of the recommendations contained in the forthcoming message of the President. It is, however, upon the Executive Heads of the War and Navy Departments, acting under the direction of the Commander-in-Chief of the Army and Navy, upon whom will devolve the important responsibility of formulating general plans for augmenting our naval strength, and for the necessary enlargement of our military forces. As regards the final character and scope of the legislation that will be enacted along the line of national preparedness, it can reasonably be expected that it will be primarily based upon the recommendations submitted by Secretaries Garrison and Daniels.

The President has given unqualified expression as to his confidence concerning the resourcefulness and ability of his War Ministers, and has shown that his confidence in both these officials is an abiding one.

The traditions and duty of the Army and Navy demand implicit respect and obedience to the desires and purposes of the President. Both Services ought therefore, unreservedly accept the fact that any thoughtful and well matured views presented by the War and Navy Departments will probably form the basis of all measures relating to national defence, that will be enacted into laws.

The loyalty and splendid example manifested by Admiral Dewey in his desire and purpose to sustain and support Secretary Daniels stand out in bold relief. The action of the Admiral of the Navy should be emulated by all his juniors, since it would not be possible to develop an efficient Service unless due homage and respect to superior officers was rendered by all. He has upheld the highest tradi-

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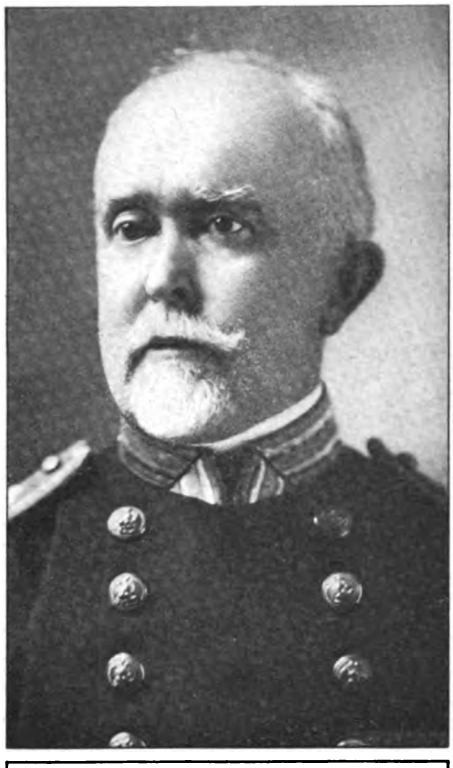

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Rear-Admiral
ROBERT STANISLAUS GRIFFIN
Engineer-in-Chief and Chief of the Bureau of Steam-Engineering

tions of the Navy as regards his official relations with the Secretary of the Navy and the President of the United States.

The personality and qualifications of Secretaries Garrison and Daniels are a matter of concern to the Nation, for in all ages the men of the hour have not only interested the multitude, but have influenced national life and national purpose, for the confidence of the people in men in high places means much to the peace, prosperity, and safety of a nation.

The varied and important duties devolving upon the Secretary of the Navy preëminently and unmistakably make for splendid service. And yet of all the Cabinet Portfolios, this office appears to be the field which invites the most calumny as well as the mast savage criticism and attack upon its incumbent. When there is considered the varied, numerous, and important activities devolving upon the Navy Department, it ought not to excite surprise that exigencies are constantly arising which cause this Department not only to be a storm center but a special field for attack upon its Executive Head, and even at times upon the President.

In analyzing the work done by our several Secretaries, it becomes essential to note the causes and conditions which frequently make this office a logical center for personal and political attack. It is necessary to have a fair knowledge of the operations of the Department to realize the tact, judgment and experience required to efficiently carry on the duties of the office. Some of the reasons for regarding the position as a logical storm center for attack upon the incumbent will be noted in the following paragraphs.

(a) CHARACTER OF DUTY ASSIGNED NAVAL OFFICERS BY SECRETARY OF THE NAVY OF FAR-REACHING EFFECT UPON THEIR CAREERS. In the administration and operation of the Fleet and of our Naval Stations there are annually issued several thousand details or assignments of individual naval officers to duty ashore or afloat. As regards a portion of these assignments or orders, some are more or less undesirable, while others may bring official distinction or preferment to the recipient. The gratitude or resentment aroused by the issuance of orders which bring distinction in the one instance, and possible professional obliteration in the other case, can only be understood in its fullness by one who himself is holding a Commission.

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(b) LABOR PROBLEMS AND CONDITIONS AT OUR NAVY YARDS. The Navy Department employs more artisans and skilled mechanics than any other Executive Department of the Government. The labor employed in the industrial shops of our Naval Stations is in general of high grade, since all classes of war vessels contain an installation of machinery that is of the most approved design and manufacture. As this installation must always be kept in the highest state of efficiency, the Navy Yard force of mechanics will undoubtedly compare favorably in skill and intelligence with the complement of any efficient commercial establishment. Substantially every privilege, emolument or right obtained by the National Federation of Labor, for the workmen of this country, has been primarily secured in great part through our Navy Yards and Arsenals. Our ex-Secretaries of the Navy have, therefore, either directly or indirectly, been most important and far-reaching factors in influencing the trend of the relations existing between Capital and Labor. Even during his brief tour of office some important industrial conditions have arisen and have been satisfactorily solved.

(c) INVENTORS DESIROUS OF OBTAINING ENDORSEMENT OF NAVY DEPARTMENT. There are but few inventors of industrial appliances who do not consider that it would inure to their prestige and financial benefit to secure Government endorsements as regards the worth and utility of their inventions. Priority of adoption and installation of certain military inventions upon our warships upon the part of the Secretary of the Navy not only may mean much to the industrial inventor, but may have an important bearing in determining relative naval strength and in promoting national safety.

Rear-Admiral JOSEPH STRAUSS
Chief of the Bureau of Ordnance

(d) AWARDING OF CONTRACTS FOR NAVAL VESSELS OFTEN INVITES ATTACK. In sending out proposals for the construction of naval vessels the Navy Department has estabished the rule of inviting competitive designs and plans upon the part of naval shipbuilders. There are important maritime and military reasons likewise, why shipbuilding plants should be established at various points along our coast, instead of encouraging the concentration of the industry in one locality. There are also cogent and impelling military reasons why it is not advisable at all times to award contracts to the lowest bidders. Is it

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DAVID WATSON TAYLOR
Chief Constructor and Chief of the Bureau of Construction and Repair

not thus apparent why the Secretary of the Navy is likely to be subjected to bitter attack as regards the manner in which the Navy is increased.

It is simply an industrial axiom that when labor is assured of congenial and steady employment, and where safety, welfare and betterment methods have been established, that the output of manufacture of any product ought under such conditions be produced in a more economical, expeditious and efficient manner. A progressive reduction in the cost of manufacture and a gain in speed construction, at all our various Naval Stations, can therefore be anticipated whenever sufficient work of any character is assigned to maintain a uniform payroll. Is it however, conducive to national defense to extensively build the industrial plants of our Naval Stations if the very existence of the shipbuilding industry, or any industry manufacturing munitions of war, is imperilled thereby?

In some instances competition with the Navy Yards has almost sapped the existence of the commercial plants. The resentment manifested at the action of the Government in progressively increasing its output of work at our Navy Yards at the expense of the commercial establishments is ample evidence that there is cause for a wide variance of opinion as to whether or not national good is promoted by carrying on in time of peace at our Navy Yards extensive industrial work.

(e) DIPLOMATIC FUNCTIONS OF NAVAL OFFICERS. Naval events that have occurred during the past twelve years in Columbian, Haitian, Nicaraguan, and Mexican waters are but illustrative of the opportunity afforded naval officers to perform service in a manner that may imperil the official existence or prestige of its Executive Head, and even in producing grave international complications.

(f) CRITICISMS AGAINST FORMER SECRETARIES. The opposition to Secretary Daniels, bitter as it may be, is but a repetition of the most vicious attacks which were directed against Secretary Welles when he was a member of President Lincoln's Cabinet; of the means employed to discredit Secretary Robeson when serving under President Grant, and of the persistent assault upon Secretary Chandler when holding the Naval Portfolio in President Arthur's Cabinet.

There have been recurring periods in the history of the Navy during the

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past fifty years, (and noticeably was this case during the administration of Secretary Wells, Robeson, Chandler and Long) when various Secretaries of the Navy had substantially to meet the issue presented to them as to whether they would be content to be a rubber stamp in carrying out the purpose of some coterie or clique that attempted to formulate the policy of the Department, or whether these Executive officials were prepared to undergo aggressive opposition and attack upon the part of those whose efforts had been thwarted. Has there not been such a storm gathering in the vicinity of the Navy Department during the past few years, and does not such a storm generally brew when war is impending? Would not therefore any one that might have been appointed Secretary of the Navy instead of Mr. Daniels have had to face some of the bitter oppositions encountered by him? Fortunately for the interest of the Navy and the Nation, every Secretary of the Navy who has been called upon to confront such an issue has met the question in a manner conformable to the purpose of the Congress when it established the office and defined its responsibilities and duties.

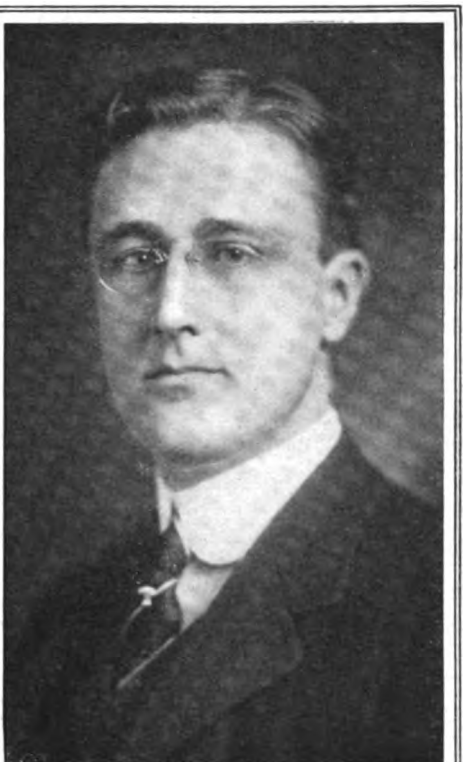

Photo by Harris and Ewing, Washington, D. C.

FRANKLIN DELANO ROOSEVELT
Assistant-Secretary of the Navy

Character of the Accusations Made Against Secretary Daniels

Before attempting to tell of the constructive and important work done by Secretary Daniels, it appears best to note the character of the offences charged against him. The *personal resentment* of any individual against the Secretary may be obliterated, for it should count for naught in measuring the general and broad work done by him during the past two momentous years.

As the policy of Mr. Daniels has been assailed along the following lines, it seems but logical to specifically meet these direct charges.

(g) Obliteration of the Aids. Within nine months of the time he assumed office, Secretary Meyer appointed, in 1909, the following Aids; that for *Operations, Personnel, Material,* and *Inspection.* It was originally intended that the work of these four offices should be distinctly advisory and particularly along the lines of correlating the work of the various Bureaus. Secretary Meyer stated, before the Naval Committee of the House of Representatives, that his purpose in appointing such assistants was to have them act as his advisors and not to delegate to them any authority coming within the domains of

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the Military and Technical Bureaus of the Navy Department. Before the close of his administration and within about three years of the establishment of the system, he had successively appointed four Aids for *Operation*, two Aids for *Personnel*, three for *Material* and four for *Inspection*. About one-half of the Aids thus appointed were exceptionally able officers and comprehended in its fullness the far-reaching purpose that Secretary Meyer had in view. About one-fourth were the ordinary run-of-mine of naval officers, while the remaining fourth appeared to have but little conception of the possibilities and purpose of the system under trial. The fact that Secretary Meyer changed his Aids so frequently is at least presumptive evidence that he found difficulty in securing the right men as his principal advisors. This system of administration undoubtedly contained some meritorious features, but even before Mr. Daniels had assumed office the activities of some of the Aids had become so obnoxious to the Senate and House Naval Committees that the fact was generally recognized that the System would soon go by the board. In fact, it was primarily due to the action of certain of the Aids in minimizing the important features of the plan, and concerning themselves with routine matters, that made the continuance of the system impossible and resulted in its obliteration.

(h) PROHIBITING THE USE OR INTRODUCTION FOR DRINKING PURPOSES OF ALCOHOLIC LIQUORS ON BOARD ANY NAVAL VESSEL OR WITHIN ANY NAVY YARD OR STATION. It is exceedingly important to note that on the third of February, 1899, Hon. John D. Long, Secretary of the Navy in Mr. McKinley's Cabinet, "after mature deliberation," as he said, issued General Order No. 508, forbidding officers or Commandants "to allow any malt or other intoxicating liquor to be sold to, or issued to, enlisted men, either on board ship or within the limits of navy yards, naval stations, or marine barracks, except in the medical department."

Secretary Daniels' order, therefore, was but an extension of that of Ex-Secretary Long. It made applicable to the Commissioned Personnel of the Navy certain regulations that were originally limited to the enlisted force of the naval service. In promulgating this order to the Service, Secretary Daniels made the following statement:

"There should not be on shipboard, with reference to intoxicants, one rule for officers and a different rule for the enlisted Personnel. I believe experience has demonstrated that a uniform rule should prevail in the navy for all who enlist in the Service, from the highest rank to the youngest enlisted man or officer who comes into the Service, and that the abolition of the wine mess will be justified."

Before issuing this order, the Surgeon General of the Navy had made a report showing the advisability of the proposed regulation. It is needless to say that this order was not favorably welcomed by the Commissioned Personnel. The hope was expectant and the belief prevalent that the President would annul the order. The writer includes himself among those who were amazed at the issuance of the Regulation and who believed that the continued enforcement of its provisions would not be insisted upon. As the events of the past year, however, have been almost staggering to humanity, the world has changed front to an amazing degree in regard to its attitude upon the enactment of sumptuary laws.

It now appears manifest that this Order or Regulation simply antici-

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pated the trend of military control of intoxicants, for such control is now in part the law in Great Britain as well as upon the Continent. The belief is now prevalent in the Navy that the order of Secretary Daniels will never be annuled by any future Secretary of the Navy. Surely time has therefore justified Mr. Daniels in his action upon this matter and also proven that he was in advance of the Navy upon this question.

(i) SHORTAGE OF ENLISTED MEN. Even such a distinguished and conservative leader as Senator Lodge has charged Secretary Daniels with being responsible for the shortage of enlisted men that now exists in the Naval Service. In reference to this accusation, attention is invited to the fact that on June 30, 1912, the enlisted Personnel of the Navy comprised 47,555 men. In August, 1912, the Congress authorized an increase of the enlisted force to 51,000 men. On the fourth of March, 1913, when Mr. Daniels assumed office the Navy had 47,347 enlisted men: during the two and one-half years that he has administered the Navy Department, the enlisted force has been recruited to approximately 51,000 men, the maximum number authorized by law.

Secretary Daniels has had but two opportunities to increase the enlisted force since he assumed office. The first opportunity was that given by the passage of the Naval Appropriation Act of June 30, 1914. The preliminary estimates for this Appropriation Bill were made in the summer of 1913, and the question may be asked, would Secretary Daniels have been justified even in contemplating any material increase in the enlisted force of the Navy within six months of the time he assumed office, and when the Navy was several thousand short of the complement authorized by law? When the fact is recalled to mind that all Estimates submitted by the Executive Departments, and particularly those coming from the War and Navy Department, are carefully scanned by such leaders as Representatives Fitzgerald and Mann, who have a most intimate knowledge of the details of all appropriation measures, it can well be imagined what would have been the fate of a request for additional enlisted men, when the Navy at that time had been unable to recruit its numbers to the complement allowed by law.

The second opportunity to obtain an increase in the Navy was by the Act of March 3, 1915. When the estimates for this Naval Appropriation were being considered by the Congress in February last, the possibility of the passing of the Dreadnaught as a result of the sinking of battleships by submarines, had made a deep impression upon the public mind. In fact, the call of the Navy at this time was primarily for ships and incidentally for men; for there was a realization of the fact that the problem at issue was whether there should be more ships or more men. Some of the ablest naval officers had certified as to the marked efficiency of some of the Divisions of Naval Militia in the Spanish-American war, although some of these Divisions had had comparatively little practical training and experience. Whereas the ships called for by this Bill could not be designed, contracted for, built, and tested under four years. (The Battleships "Nevada" and "Oklahoma" authorized by the Act of March 4, 1911, had not then been placed in commission, nor are they ready for commission now.)

(j) EDUCATIONAL ACTIVITIES CONDUCTED ABOARD SHIP. During the past two decades, probably every Secretary of the Navy after assuming office has been informed of the fact that the percentage of re-enlistments

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in the Navy was far short of what it should be for the good of the Nation. The pay of the enlisted personnel of our Navy is munificent as compared with that accorded the enlisted personnel of any other navy. The average annual pay of the German bluejacket is $108, while that of the British is $196, and ours $481. The ration of the American bluejacket is more extensive and varied as well as more nutritious and palatable than that of the enlisted men of any other Naval Service. The opportunity for advancement to Warrant and Commissioned rank in the Navy of the United States is greater than that of any other Naval Organization. And yet, but less than sixty per cent of these men re-enlist—a deplorable if not a startling condition.

Is it surprising, therefore, that every Secretary of the Navy for the past generation has made some special effort to encourage and induce more of our sailors to re-enlist?

Various vocational schools have been established at our several naval stations and at present there are about eleven hundred and fifty enlisted men at our shore stations receiving vocational training. The trend of all vocational service training heretofore had been in the direction of having the work done on shore.

In the industrial world there is a marked tendency towards extending the sanitary, safety, betterment and welfare conditions of the employed. It is exceedingly probable that due to improved conditions of the workmen on shore, that we may find one of the important reasons why the bluejacket of the Navy fails to re-enlist.

Various predecessors of Secretary Daniels, despite their earnest and resourceful efforts to induce a large number of the enlisted complement to re-enlist, substantially failed in the attempt. Was it not natural, therefore, that Mr. Daniels, when his attention had been specifically called to this matter, should likewise seek some method whereby a larger complement of our enlisted Naval force might be induced to make the Navy a life career?

Wherein was the incongruity or impractibility of extending the vocational training now given to enlisted personnel at various shore stations by likewise giving instruction on board ship? If it is of advantage to the Naval Service to give special training on shore to about two or three per cent of the enlisted Personnel, why is it not desirable and even practicable to give at least a limited amount of instruction afloat to at least a portion of the remaining ninety-seven per cent of the enlisted force?

It must be admitted that the Navy at first was startled at the suggestion of the Secretary to carry on, to any extended degree, school work on board ship. Is it not a fact however, that less than fifty years ago the officers of the European navies substantially received all their educational training and education afloat? Were not our Naval Commanders of the Revolutionary War, of the War of 1812, and of the Mexican War trained solely aboard ship? Are the Commanders and Flag Officers of our Squadrons, Divisions and Fleets forwarding any recommendation for the abandonment of Mr. Daniels' educational project? Is not the purpose laudable, and the experiment worth trying?

As for the practical success of Secretary Daniels' effort to carry on educational work afloat and thus stimulate re-enlistment, the following data may afford some reliable information upon the matter. The number of enlisted men actually enrolled for immediate service during the past two years has been increased by

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5,484 men, but more gratifying even than this is the increase in re-enlistments. During the fiscal year 1915, there was a re-enlistment of 85.5 per cent of the men who were entitled to this privilege. For 1914 the percentage was 72.4 per cent; an average for the two years of 79 per cent, as against an average of 58.5 per cent during the previous four years. While there were various other causes, such as the possibility of war, and the enactment of the Naval Reserve Bill, which contributed to increasing re-enlistment, the educational work conducted on board ship was a very contributing factor in increasing the composition of our ships with seasoned crews instead of a complement composed mostly of men in their first enlistment.

(k) HAS THE EFFICIENCY OF THE NAVY BEEN IMPAIRED SINCE MR. DANIELS ASSUMED OFFICE? The vague and indefinite charge has been made, and has been widely published, that the morale and efficiency of the Navy has been impaired by the manner in which the duties of the Department have been administered during the past two years.

The accusation is so general that it is not possible to reply specifically to such an attack. The Admiral of the Navy however has spoken in an unqualified manner upon this particular point. Under date of May 14th, 1915, in requesting that there be conveyed to the Mayor and citizens of New York City his sincere regrets at his inability to be present at the ceremonies incident to the review of the Atlantic Fleet, Admiral Dewey then wrote:

"The people of New York have just cause for pride in the fleet now assembled in their harbor. Not only is it composed of the finest and most efficient warships that we have ever had, but it is not excelled, except in size, by the fleet of any nation in the world. Our ships and guns are as good as any in the world; our officers are as good as any; and our enlisted men are superior in training, education, physical development, and devotion to duty, to those of any other navy. As President of the General Board for the last fifteen years, I can say with absolute confidence that the efficiency of the fleet has steadily progressed and has never been so high as it is to-day."

If the efficiency of the fleet has been steadily progressing, was it possible to have had anything but an efficient administration of affairs at the Navy Department for the past two years?

(l) OFFICIAL RELATIONS WITH THE GENERAL BOARD OF THE NAVY. It will probably be found that the crux of the opposition manifested toward Secretary Daniels is primarily due to the attitude of the Secretary in his relations with the General Board. Concerning the extent of Naval development that should be reommended to the Congress, the Secretary has not altogether been in accord with recommendations submitted at various times by this Board. When formulating any plan of Naval development the Secretary is compelled to give heed to the financial condition of the Treasury, the probable revenue of the Government, the counsel of the Chairmen of the Appropriation and Naval Committees of the Congress, and particularly to the policy of the President. The General Board's recommendations, however, are submitted independent of the executive and Legislative views of the matter. Since the General Board's recommendations are submitted without special reference to the state of the Treasury, or to the views of the leaders in Congress, it is not surprising that their recommendations are not unreservedly accepted by most Secretaries of the Navy. Surely such action ought not be regarded as ignoring the recommendations of the military advisors.

In frankly commenting upon the duties and relations of the General Board with the Secretary of the Navy

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THE ADMIRAL OF THE NAVY
WASHINGTON

May 14, 1915.

My dear Mr. Secretary:

I trust that you will be good enough to convey to the Mayor and citizens of New York City my sincere regret at my inability to be present at the ceremonies incident to the review of the Atlantic Fleet, and my cordial appreciation of the hospitality they have shown in the reception of the officers and men.

On this occasion I recall with the utmost pleasure, the magnificent welcome I received in their great city upon my return from Manila on board the OLYMPIA in September 1899, and it is a source of deep satisfaction to know that the interest of our citizens in their great Navy has not diminished in the sixteen years that have elapsed since that time.

The people of New York have just cause for pride in the fleet now assembled in their harbor. Not only is it composed of the finest and most

FACSIMILE OF LETTER FROM ADMIRAL DEWEY TO SECRETARY DANIELS

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efficient warships that we have ever had, but it is not excelled, except in size, by the fleet of any nation in the world. Our ships and guns are as good as any in the world; our officers are as good as any; and our enlisted men are superior in training, education, physical development, and devotion to duty, to those of any other navy. As President of the General Board for the last fifteen years, I can say with absolute confidence that the efficiency of the fleet has steadily progressed, and has never been so high as it is today.

However, we need more ships, more officers and more men, and should continue the wise policy of increasing the size of our navy, which must ever remain our first and best line of defense. This defense unless adequate is impotent; and adequacy is not reached until the navy is strong enough to meet on equal terms the navy of the strongest probable adversary.

Very sincerely yours,

The Honorable
Josephus Daniels,
Secretary of the Navy,
Washington, D. C.

FACSIMILE OF LETTER FROM ADMIRAL DEWEY TO SECRETARY DANIELS

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the fact should be understood that such comments are intended to be absolutely impersonal. The membership of the General Board repesents an exceptionally able complement of officers, and therefore no criticism of the individual is implied. The work of the Board as a whole, however, vitally concerns naval preparedness. Should not the province, influence and continuance of the Board be dependent upon its readiness and ability to meet any issue upon which there is wide variance of opinion, and should it not be compelled to sustain every recommendation of far-reaching importance and effect?

The general scope and purpose of the Board commend themselves to all interested in an efficient Navy. The conviction is deep-seated throughout the Service that the recommendations of some such Board should count for much in the development of a well-rounded organization. While the Board has rendered conscientious and efficient service, it has not been of any higher standard than that performed by other naval officers assigned to important duties.

The existing and overshadowing weakness of the General Board rests in the fact that this body contains too few members and that its composition is too frequently changed. If the membership of any Board should be of a continuing nature it should certainly be that of the General Board. Have there not been too few assistants detailed in connection with its important and extensive duties? Has it been supplied with an adequate clerical force and does it occupy sufficiently commodious quarters to efficiently carry on its work? Does its active and permanent membership include any recognized national expert authority upon marine machinery, hull design, under-water structure, or any expert upon matters relating to the problem of supply and transportation, or any standard authority on hygiene and sanitation?

The studies and conclusions of the War College are at the command of the Board. Its membership includes the President of the War College, the Chief Intelligence Officer, and the Commandant of the Marine Corps, and its composition is distinctly strengthened by such appointments.

The purpose and scope of the work of the General Board must be made known in its fulness to recognized experts, if their views upon any important matter is to be accorded any weight. These men must be placed on terms of official equality with the Board in order to render careful judgment upon the important technical matters that confront them. Every naval engineering expert is appreciative of the fact that profesional technical advice upon matters concerning such questions of importance as that of Naval preparedness can not be obtained at will like drawing water from a spigot. While every expert detailed to duty in connection with the General Board tries to give to the Board the best that is within him, it is simply impossible for them to render that personal and valuable service which goes forth from men who know that the measure of their work is appreciated, and who are given time and opportunity to present their professional views.

As a rule the composition of the General Board has not been superior to that of the collective Bureau Chiefs, and this fact is recognized by all thoughtful naval officers. The tour of service of the average Bureau Chief in the past has been at least four years, while the tour of duty of the members of the General Board has probably not averaged over half

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that period. Each Bureau Chief possesses an organization which can be regarded as an efficient machine and one that has been progressively and thoughtfully developed. How can the General Board be expected to cross swords upon professional matters with the Technical Bureau Chiefs until its membership includes recognized authorities upon every phase of naval development?

Ought it, therefore, be a matter of surprise that ever since the Board was organized, its recommendations have not been given, by the Senate and House Naval Committees, that consideration which should have been accorded the views of a Board of such character? And such will probably continue to be the case until the membership of the General Board is enlarged and thereby made into a well-rounded organization. The leading committees of the Congress expect and have the right to demand that recommendations involving the expenditure of millions of dollars should represent the thoughtful views of experts, and not the filtered opinions of recognized authorities collected from various sources.

Neither the opinion of this Board nor that of any other should be regarded as *ex cathedra* upon matters of policy, for there are too many phases of the subject to expect that the Executive and Legislative Departments of the Government will surrender their prerogatives to a Board whose important recommendations have not always stood the test of time. This Board should be no more immune from criticism than should the work of any one of the Industrial or Technical Bureaus. In brief, the practical influence of the General Board is far less than what should have been accorded a Board whose scope and purpose is as far-reaching as this one. The General Board, however, like every individual of the Board, is but human, and if at times it is in error, it should not resent sincere and thoughtful criticism as hostility to its general work and purpose.

The friends of the General Board, however, have the right to demand that some specific instances be cited wherein the work of the Board has not risen to that height which ought to have been expected of it. In citing such instances the purpose will be simply to try to show that efficiency is not promoted by permitting any Technical or Advisory Board to regard itself as immune from criticism. Attention is therefore invited to a few instances where the prestige and judgment of the General Board has been somewhat impeached by reason of recommendations which have not stood the test of time.

(m) RECOMMENDATION OF BOARD TO CONSTRUCT SMALL SIZED BATTLESHIPS. Did not the General Board in 1903 submit a special communication to the Secretary of the Navy substantially maintaining that the trend of construction of battleships toward heavier tonnage was in conflict with tactical and strategical reasons? Was not the construction of the battleships "Idaho" and "Mississippi" an outcome of this recommendation? Did any other able technical experts at that time, hold any such belief, except Vice-Admiral Hopkins of the British Navy, and Rear Admiral Stockton of the American Navy?

(n) RECOMMENDATION THAT ONLY TWO GREAT HOME BASES BE ESTABLISHED ON THE ATLANTIC COAST. Did not the General Board about three years ago, substantially maintain that two great home bases with several subsidiary Navy Yards could meet American Naval demands on the Atlantic coast? Was it not recommended that Hampton Roads and Narragan-

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sett Bay be settled upon as the location for such great home ports? Did not the General Board within a year substantially change front upon this question and substitute New York for Narragansett Bay? When it is remembered that the Capes of Virginia are less than 200 miles distance from Sandy Hook, can it be expected that the country at large will ever accept the conclusion that two great home bases so closely contiguous to each other as New York and Norfolk, can meet all the important industrial military demands of our Fleet? The Congress of the United States, upon whom rest the responsibility of providing for the defense of the whole of the Atlantic coast, will never accept the doctrine, that only two great home bases on the Atlantic coast are required and that they should be located within 200 miles of each other.

When there is considered the limited suitable territorial area that could possibly be acquired for home Naval base purposes at the port of New York, together with the industrial conditions that exist in the vicinity of tidewater Virginia, no substantial support will ever be accorded by the Congress of the United States to the proposition, that the development of these two home bases on the Atlantic coast alone would meet the immeasurable Naval demands that would arise if we came in conflict with a combination of continental powers. In expressing this view, one need not minimize in the slightest degree either the incomparable natural maritime and industrial advantages of the Harbor of New York, or the wonderful military possibilities of the lower Chesapeake Bay, as a point for the concentration and distribution of supplies together with the advantages of Hampton Roads as an assembling point.

(o) Is It Practicable to Develop a Great Outlying Naval Base at Guantanamo? Has not the problem of Guantanamo been before the Navy Department and the Congress for the past fifteen years? Has not the unequivocal recommendations of the General Board for the establishment of a great outlying Naval base at Guantanamo been periodically presented to the House and Senate Naval Committees since 1900? Has any convincing brief ever been presented in behalf of the proposition that fully commended itself to any Naval Committee? Has any Secretary of the Navy ever given a cordial and continuous support to the proposition? Has not continued study of the matter upon the part of many naval officers developed growing and serious doubt as to the overshadowing military value of this harbor? If Guantanamo is of the strategic importance claimed for it, did not our Naval experts seriously err in not acquiring on the southern coast of Cuba a Naval Reservation instead of leasing it? Did not the Platt Amendment empower this Nation to acquire or lease a Naval Reservation on both the Northern and Southern coasts of Cuba? Who was responsible for selecting a Naval Reservation like that of Bahia Honda on the northeast of Cuba when that station possessed so little strategic importance that the Navy never made any attempt to develop the reservation? Was not the original site obtained for a Naval Station at Guantanamo too small in extent and too near the sea? Is not even the second Naval site that was acquired too limited in extent to solve the problem of obtaining an adequate and potable supply of fresh water, and is not the new site so located as to permit a possible enemy to observe the station from the sea and thus easily destroy every important struc-

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ture on the station? Is not the question of obtaining an adequate supply of fresh water an exceedingly difficult one, if not almost insurmountable, taking into consideration the cost of the extensive fortifications that would have to be constructed for the defense of the water supply if not for the land defense of the station? Has any attempt whatever been made by the military authorities to fortify the Reservation? It may be that there is but little possibility of the station ever being attacked by the Cubans, but the probability is not remote that some foreign power might land on the coast of Cuba and attempt to capture the station from the land side. There is something surprising in the knowledge that for fourteen years the development of our Naval Stations on the south Atlantic and Gulf coasts have been checked, pending a definite decision as to the advisability if not the possibility of developing the projected outlying Naval base at Guantanamo. Has its military and strategic value ever been acknowledged by the military authorities? Have not the military experts hesitated to prepare any plans for the fortifying the stations until the Army could be assured that an adequate and reliable water supply could be furnished for the large contingent of troops that would be required there, in case Guantanamo were developed as a great Naval outlying base in the Caribbean? Probably every thoughtful Naval student interested in the welfare of America has given expression to the spirit of the opinion, that if the United States is ever called upon to wage a Naval conflict, the decisive Naval battles of the war may be fought in the Caribbean. If Guantanamo is a logical base for the operation of our Fleet, and if the solution of the water supply problem is not insurmountable, then millions of dollars should be immediately expended in developing the project. If this harbor possesses inherent military weaknesses, then the fact should also be known. Pertinent to this matter, the Board of Inspection for Shore Stations submitted a report that represents exceedingly careful study of the problem.

(p) CONSTRUCTION OF BATTLESHIPS BURNING FUEL OIL EXCLUSIVELY. Has not the General Board stood sponsor for the proposition that all our battleships should be fitted with boilers using liquid fuel exclusively and have we not followed this policy for the past five years? Except the four British battleships of the Queen Elizabeth type, no other battleship in the world has been designed to use crude oil exclusively for fuel purposes. Is there one harbor in the Caribbean outside of the Canal Zone, which permanently maintains on hand 10,000 tons of fuel oil—an amount about sufficient for the supply of a Division of four oil-burning battleships of the Arizona type? Are we not also woefully weak in oil tankers?

The limit of this article will not permit extended discussion of this feature here, but the question of an oil-fuel supply is one which within a few years may disturb the serenity of those who advocated oil-burning battleships and did not insist upon adequate tankers and the necessary dry docks on our Southern coasts. The advantages and disadvantages of building battleships with an exclusively oil fuel installation will be tested during the coming year. It is to be hoped that it may not be found regrettable that the membership of the General Board did not include a technical expert and one who had given special study to the subject when this question was given extend-

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ed consideration by the Board about five years ago, since there were available several officers who had given continuous study for years to the matter.

(q) DISCRIMINATION AGAINST THE NORTHERN NAVAL STATION. It is rather in an insidious than in an open manner that Secretary Daniels has been criticised for discriminating against Northern Naval Stations. If there is one charge that is baseless it is this one; since, as a matter of fact, if any discrimination has been exercised it has been against the Southern Naval Station. There are about twenty-five hundred miles of seacoast on the South Atlantic and Gulf Coast between Cape Hatteras and the Rio Grande; there are about twelve hundred and fifty miles between Cape Hatteras and Eastport, Maine. Two-thirds of our seacoast on the Atlantic is therefore to the southward of Cape Hatteras. There is not a dry-dock possessed by the Government or by anyone else on the South Atlantic or Gulf Coast which will dock any of our Super-dreadnaughts. There is not a single stationary or floating crane possessed by the Government, by any individual or by any corporation, to the southward of Cape Hatteras, which will remove from or install in a battleship either a modern turret gun, a modern Scotch marine boiler, or an assembled low-pressure turbine of the type installed either in one of our Dreadnaughts or in our large naval colliers or tankers. In brief, for a distance of twenty-five hundred miles along our Southern seacoast we cannot make extensive repairs to any battleship that we possess. If measured from the standpoint of War requirements, then, the storehouse facilities of the Southern Naval Stations are pitifully weak. There is substantially but one Naval foundry to the southward of Cape Hatteras and that is the foundry at Charleston, S. C., Naval Station. Here there is a forty-ton traveling crane and it is the only one possessed by the Navy Department on either the South Atlantic or Gulf Coasts; it only operates on one side of the dry-dock. Although the Charleston Navy Yard is the home port of twelve torpedo-boat destroyers, that station does not even possess a floating derrick that will handle the various appliances, such as turbines, evaporators, steering engines, etc., that have to be repeatedly removed and replaced in these destroyers. There is not a Southern yard possessing a shop capable of building the boilers of a sea-going tug, and yet we hear talk of the discrimination that has been shown against the Northern Navy Yards by Secretary Daniels. It makes for the good of the Navy and the Nation that the Southern communities are waking up to the real condition of affairs as regards the inefficiency of their Naval Stations on the South Atlantic and Gulf coasts, and that this matter will be given special consideration at the next meeting of the Southern Commercial Congress, which body will meet in Charleston in December next.

While Secretary Daniels has opened up the New Orleans and Pensacola Navy Yards to a limited degree, such action bears no comparison to the extent to which he has promoted development of the Northern Naval Station, and therefore the most unfounded charge that can be brought against him is that Sectionalism has been manifested in his management of the Navy Yard.

HAS SECRETARY DANIELS MADE ANY MISTAKES?

The question may be asked in view of the trend of this article if Secretary Daniels has made any mistakes during his term of office. Yes, mis-

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takes have been made, and it is not surprising that such should be the case. Mr. Daniels has made both an earnest and constant effort to accomplish extensive and important constructive work, and it is to be expected that he would encounter obstacles which happens to everyone who attempts to do things.

In the effort of the Navy Department to purchase supplies more economically and to debar, if necessary, a call for proprietary articles, needless and exasperating delays followed. The General Storekeeper's records of the New York Navy Yard show that tens of thousands of articles of various sizes of form and quality are required to maintain the Fleet in a state of efficiency; it was not, therefore, possible for anyone to handle requisitions for the maintenance of such extensive supplies except the Bureaus which had cognizance of such matters. Important travel orders for officers were either refused or reluctantly granted. Parts of the machinery of our battleships that could have been manufactured in the United States were purchased abroad. In reference to this matter, however, some of our manufacturers were asking such excessive prices for the articles required, that it was manifest they were demanding excessive profits or else that their facilities for fabricating the material required were inefficient or antiquated.

The slogan of economy as regards the purchase of certain standard supplies was in some instances carried too far. In justice to Mr. Daniels it should be stated that there was a considerable contingent of the House Naval Committee who believed that there had been excessive waste and extravagance, if not incompetence, in conducting the affairs of the Navy Department. The fact was not known to them that the modern battleship is insatiate in its demands for supplies. It requires an expenditure of several thousand dollars a day to operate one of these vessels and when there is shortage of stores or when machinery parts become disabled, economy is promoted by working overtime as well as by the purchase of necessary material at the best prices obtainable. The regulations in regard to Sunday work were probably interpreted too strictly. The prices of certain commodities have varied greatly since Mr. Daniels assumed office, and therefore the cost of an article one day could not be used as the standard of the price several months subsequently; the varying price of liquid fuel during the past three years is an illustration of this fact. The receptiveness of Secretary Daniels to advice and counsel, along the economy line, soon resulted in an improvement of affairs in this respect. It should be stated, however, that along certain lines he effected general economies that resulted in very heavy savings. The abolition of the Board of Inspection for Shore Stations was a mistake. If the composition of the Board was wrong it was a simple matter to change its membership. Efficiency, economy and progress were promoted by having all our Shore Stations receive inspection independent of that made by the Commandants of the respective Stations or by Bureau representatives who had a very direct interest in certain features of administration. The service at large however fully understands something of the extent and character of the opposition that existed in Naval circles to the work of this Board. The various reports submitted by this Board, some of which have been published as Senate documents, best tells of its work, and the necessity for such a Board.

The work of every one, however, can only be judged by the general re-

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sult accompished. It would be a commonplace administration which did not make mistakes, and it would be one which would be subjected to much more extensive and bitter attack than an organization that attempted to do things, for development along modern Naval lines necessitates constructive and original work that not only invites criticism but also some disappointments and mistakes.

(r) IMPORTANT AND EXTENSIVE RETRENCHMENTS EFFECTED BY THE DEPARTMENT. While temporary mistakes that provoked exasperating delays and aroused resentment were made in the effort to economize along several lines, exceedingly substantial and important results were achieved by the Secretary when he personally took charge of the work of effecting retrenchment. Can the following facts be controverted as regards effecting economies that were not only far-reaching when measured from a financial, but, more important still, when considered from a military point of view?

POWDER. Is not the capacity of output of the Navy Factory at Indian Head being increased from about 3,000,000 to about 5,000,000 pounds of powder per year and has not the cost of manufacture at this plant been reduced by 2.7 per pound?

ARMOR PIERCING AND COMMON PROJECTILE SHELL. Has not the price for 14-inch shell during the past two years been reduced from $490 to $425, and that of the 12-inch shell from $272 to $165? Has there not been a reduction in the price of the 5-inch common projectile shell from $13.30 to $12.00? Over one and one-quarter million dollars saving has been effected in the purchase of armor piercing shell and common projectile.

ARMOR. Since Secretary Daniels assumed office, have not the following reduced prices been obtained in the various classes of armor?

TABLE A Type of Armor	TABLE B Cost		TABLE C Cost		TABLE D Cost
Class A1	from $454	to	$440	and to	$425
Class A2	" 518	"	504	" "	486
Class B	" 496	"	471	" "	466
Class C	" 548	"	448	" "	376

Table B gives the price paid for armor for the battleship Pennsylvania, the contract for which was awarded previous to the time Mr. Daniels assumed office. Table C gives the price paid for armor for the first year of Mr. Daniel's administration for the battleships of the Arizona class. Table D gives the prices obtained on the armor for the three dreadnaughts authorized at the last session of Congress.

The savings on armor alone will approach eleven hundred thousand dollars.

MIXED ACIDS FOR NITRATING COTTON. Prior to the existing European War the capacity of output of mixed acids at the Naval Powder Factory at Indian Head was about five million pounds; its cost of manufacture being about three cents per pound. The cost of purchasing this product from the commercial firms was likewise about three cents per pound. With the outbreak of the War, the cost of the commercial product progressively increased until the Government was finally compelled to pay about seven cents per pound when making a contract of four million pounds of the product.

An additional supply of nine millions of pounds of acid being required for Governmental purposes, it was found that the articles could not be purchased under $0.0698, or practically seven cents per pound, which price was regarded for that large quantity as excessive. The Secretary then determined to increase the output of the Indian Head Factory and not to look to the commercial firms to supply this demand. As a result of the recommendation of the Secretary of the Navy, and to meet the military exigency that confronted the Department, the President authorized an extension of the plant of the powder factory. As regards the manufacture of these nine million pounds of acid, the Department expects to obtain all the product called for, pay for the necessary extension of the plant, and then have a balance of $172,000 remaining out of the amount which would have been expended had the contract been awarded at the price asked by the commercial firms.

TORPEDOES. For every one hundred torpedoes which the Navy Department had on hand on March 3, 1915, the Navy Department now has ninety-six more in the course of manufacture. Before Mr. Daniels will have completed three years of service, our supply of torpedoes will be practically doubled. The capacity of output of the Newport, R. I., torpedo factory has been doubled, the time of manufacture lessened, and the cost of manufacturing torpedoes reduced from $4202 to $3241.

A third plant for the manufacture of torpedoes has been started at the Washington Navy Yard. Does it not seem all important that a fourth plant should be established at Charleston, S. C., for there are important sentimental, industrial, and military reasons demanding the establishment of such a plant at some point on the South

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Atlantic Coast. A fifth plant should be established at some point on the Pacific Coast.

TRANSPORTATION. As a result of thoughtful and extended study upon the part of Naval experts as regards improved methods of transferring supplies and routing bodies of enlisted men, the Bureau of Navigation along this line has been able to effect a saving of over $175,000 during the past fiscal year.

MINES. For every nine mines that the Department possessed two years ago, it expects to have thirty-one before the end of 1915. A saving of $175,000 has been effected by having the work done at one of our Naval Stations instead of purchasing the mines abroad.

The manufacture of additional mines is another industrial activity of the Navy Department which should be started without delay at one of our Naval Stations south of Cape Hatteras as well as at one of our Naval Stations upon the Pacific Coast.

IMPORTANT CONSTRUCTIVE WORK DONE BY SECRETARY DANIELS

In measuring the accomplishments of efficient leaders and administrators, the all important test is to note and take account of the extent and character of the far-reaching and distinguished service rendered by them. Judged from this standpoint, has not the administration of Mr. Daniels been distinguished by the accomplishment of the following and important constructive work? Has he not advanced the strength and efficiency of the Navy along the following lines?

(s) PROVIDED A VERY MATERIAL INCREASE IN THE TONNAGE OF THE NAVY. Has not there been authorized during the past two years a very material increase in the number of Submarines, Destroyers, Naval Auxiliaries and Battleships? When Mr. Daniels assumed office did not a even majority of the leaders of the House of Representatives expect him to retrench in the direction of increasing our Naval strength? Did he not convert many of these men to his views? Did not the last Act making appropriations for the Naval Service provide for a greater increase in tonnage of war vessels than any Naval Bill that was ever enacted into law by the Congress of the United States? Did it not require tact, ability, and moral courage to obtain an increase under such conditions? Exceptional moral courage and resourcefulness was manifested in obtaining this increase, for even in President Wilson's Cabinet, were there not powerful influences that considered an increase in Naval strength unnecessary? Was not the deficit in the Revenues of the Government increasing, and did not a large number of Chairmen of Committees of the House vote against the increase urged by the Navy Department? The success achieved by Mr. Daniels along this line of constructive work is surely evidence of his initiative and executive ability as well as his power and influence with Congress.

(t) EXTENDED THE WORK OF THE NAVAL WAR COLLEGE. Has not the average number of Commissioned Officers attending the War College been considerably increased, if not doubled, during the past two years? Are there not now several hundred officers attached to cruising ships or stationed at various Naval Shore Stations, now keeping in direct touch with the work of the War College by pursuing an advanced military educational course along the line of a study of the higher science peculiar to the art of Naval Warfare? Does not the military history of the world show that each generation, if not each century, produces but few over-shadowing leaders, and will not the extension of the work of the College that has taken place under the direction of Secretary Daniels very materially increase the possibility of developing Naval Commanders possessing the resourcefulness, knowledge, and genius that are associated with the names of Drake, Farragut, and Nelson?

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Was not, therefore, constructive ability of the highest order, exhibited upon the part of Secretary Daniels in extending the work of the War College, for were not the possibilities of the College thereby augmented? The years of uncertainty are the years to be, and while it is to be hoped that, for this Nation, the coming years may be years of peace, does not our duty to humanity, if not for naval preparedness, demand that if there is a call for the augmentation of the Fleet, there should be coincidentally developed and made available for the ships a trained enlisted force, efficient and resourceful Officers, and over-shadowing leaders capable of successfully handling every important question of strategy and policy that confronts them?

(u) EFFICIENT AND ENDURING DRY-DOCK AND QUAY WALL CONSTRUCTION. Only those interested in dry-dock construction and who performed duty at the Navy Department in 1913-1914 can have the slightest realization of the thoughtful and extended study given the dry-dock question by Secretary Daniels. Even during the two years that he has been in office, there has confronted him two important questions relating to the building of under-water structures.

At this stage of our Naval development the construction of additional dry-docks and battleship piers is as essential as the building of the ships. Would not an expenditure of $15,000,000 for dry-dock and pier wall extension at our various Naval Stations do more in promoting the efficiency of the Fleet than would be obtained by augmenting the Fleet by the addition of a single battleship? The work of Secretary Daniels in forcing to an issue the dry-dock question constitutes one of his most important constructive acts. In addition to recommending the construction of a modern dry-dock at Norfolk he has but to urge that additional modern dry-docks be immediately authorized for Philadelphia, Charleston, S. C., some point on the Gulf of Mexico, and an additional one on the Pacific Coast. Such recommendation would round out the splendid constructive work that he has done in this respect.

(v) AUGMENTING THE EFFICIENCY OF THE OPERATION OF THE FLEET. In response to the urgent demands of the Navy, various Secretaries during the past fifteen years have urged the Congress to re-establish for the Navy the ranks of Admiral and Vice-Admiral, and likewise to provide some Statutory Office or Board whose province it would be, under the direction of the Navy to co-ordinate and develop operations of the Fleet. In accordance with the recommendation of Mr. Daniels, the Act of March 3, 1915, not only contained a provision for the re-establishment of the grade of Admiral and Vice-Admiral of the Navy, but the Act likewise provided for the establishment of the office of Chief of Operations. Is not the Navy indebted in a great part to the effort of Secretary Daniels in securing this legislation? Is it not a distinct mark of leadership and ability upon the part of any Cabinet Minister to obtain from the Congress legislation of a character that has been repeatedly recommended by his predecessors, but which had been heretofore ignored or refused?

(w) INDUSTRIAL MANAGEMENT. By reason of the official recommendations and deep personal interest of Secretary Daniels in matters pertaining to the development of Marine Engineering and Naval Architecture, there was incorporated in the Act of June 30, 1914, an amendment empowering the Secretary of the Navy to detail former Engineer Officers,

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and likewise Naval Constructors to perform any shore duty, commensurate with their rank, to which they might be assigned by the Secretary of the Navy. The engineering world of this country owes Secretary Daniels an inestimable debt of gratitude for his action in the matter since it is a distinct tribute to the work and worth of the Engineer. Under the provisions of this Act it is now within the province of the Secretary of the Navy to order Engineer and Construction Officers as Commandants of Naval Stations or to any other shore duty commensurate with their rank.

Two officers of the old Engineer Corps of the Navy have been detailed as Commandants of Naval Stations in conformity with the provisions of the Act of June 30, 1914. It ought make for the economical and efficient administration of our Navy Yards that such assignments are possible, since the extended industrial experience possessed by these Officers combined with their engineering experience afloat ought eminently qualify them for such duty. Industrial engineering efficiency under existing Naval conditions is simply synonymous with military efficiency.

(x) APPOINTMENT OF AN ADVISORY COUNCIL OF EXPERTS ON INVENTION. The possibilities of such a Council are vast, and yet it does not make either for engineering efficiency or promote naval preparedness to anticipate any early substantial results from its work. Some very important recommendations, it may be expected, will be presented by this Council even before Congress assembles.

The prestige of the individual men who have been honored by appointment to Membership on this Council, as well as the confidence of our people in the judgment of the Navy Department, will be seriously impaired if the fact is not recognized that for a time the work of these Experts must be along directive lines whereby they may ultimately be able to render the distinct service for which the Council was organized. In fact, the Navy and the Nation must look to the future rather than to the present for substantial and practical results from the work of this Council.

It ought be anticipated that this Advisory Council should be an influential and permanent factor in inducing Congress to grant liberal appropriation for original research work and investigation along both Naval and Military lines.

MILITARY VALUE OF THE COMMERCIAL SHIP YARDS AND PLANTS FOR MANUFACTURING MUNITIONS OF WAR

Important as it may be to increase the size of the Fleet, it is equally important that corresponding attention should be given to improving the efficiency of our Naval Shore Stations, encouraging the extension of the commercial ship yards, and developing plants for manufacturing munitions of war. The prolongation of the war in Europe can in part be ascribed to the fact that, except Germany, no other Nation appears to have had due appreciation of the inestimable military value and necessity of possessing an adequate number of commercial plants capable of turning out munitions of war.

In any thoughtful and well considered plan of Naval campaign that involves operations against this Nation, foreign experts have undoubtedly given serious consideration to the existing facilities that we possess for constructing battleships, manufacturing armor, and turning out powder projectiles, rifles and machine guns? Do they not measure our naval strength by these resources, as well as by our strength in battleships?

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Conclusion

It should be a matter of ineffable satisfaction to the Nation that not only the Secretaries of the War and Navy Departments, but likewise the President, is exceedingly appreciative and receptive of conscientious and thoughtful information and counsel relating to matters pertaining to National preparedness.

There has been much that has already been done by the War and Navy Departments along the line of preparing well matured plans for Naval and Military development. Supplementing the efficient work that has been done by Secretaries Garrison and Daniels, is there not one important work which they can do in common? It is a work which has never been systematically attempted before. It is the preparation of some joint or co-operative plan of National preparedness which would provide measures whereby there could be obtained equality of opportunity, of promotion to Officers of both branches of the Military Service. For every convincing reason which has been advanced for authorizing the grade of Admiral and Vice-Admiral to be established, there exists some equally cogent reason for according the Army correspondingly distinctive grades.

The profession of Arms is worthy of recognition upon the part of our Nation. When there is considered the important responsibilities that may devolve upon those who will command our land forces, every encouragement should be offered the elect of the Army to make that branch of the military service a life career.

Efficient and cordial co-operation between the Army and the Navy demands that the discrimination now existing as regards the lack of honors that are denied our General Officers of the Army should cease. There can be no efficient Navy if justice and due recognition is in any way denied the Army. Does not West Point substantially stand discredited if its graduates can not obtain the corresponding grade and rank accorded the Annapolis graduate.

The work of Secretary Daniels has been one of distinct and important accomplishments. His integrity of purpose has never been assailed. His receptiveness for counsel is exceedingly marked. His deep affection for the Service ought best be reflected by his memories of the Spanish-American war. Admiral Dewey certifies that at no period in the history of our Nation has the morale of the Naval Service been higher. Surely it ought be written of one of whom such tribute can be justly paid that in administering efficiently the great trust reposed in him he has upheld the best traditions of the Navy.

The spirit and confidence of the military services goes forth to the President at this critical hour. There are periods when the courage of conviction, founded upon the consciousness of a high sense of duty and the weight of a great responsibility brings forth results which may mean more to a Nation than any action which invites the courage of the crisis. It may be that the Service already rendered, through courage of conviction, has carried us through a great crisis. If, however, there awaits this nation the possibility of eventually becoming involved in the existing conflict, as an outcome of this War of the Ages, will not the events of the future condemn us and will we not fail in the great mission assigned us, if we even hesitate to develop calmly yet expeditiously and completely, a system of National preparedness commensurate with the possible danger confronting us?

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How the Navy Department is Organized

We have endeavored from time to time to keep the readers of THE ENGINEERING MAGAZINE familiar with the organization plans of the Navy Department. Herein is described cartographically the ideal organization (possible only with a monarchical government), the system developed under Secretary Meyer's administration, and the modifications of that system now in operation.—THE EDITORS.

AN ideal military organization, possibly, is that directed and controlled by a General Staff, working under the directions of a Commander-in-Chief and his Chief of General Staff, which is *peculiarly suited to a monarchical government of the absolute type,* with a monarch as Commander-in-Chief, or this position delegated to a high-ranking military officer, such as, for instance, Admiral Von Tirpitz of the German Navy. He sits at the head of his own council board, and his staff, including the Chief, are his subordinates and report to him. Through the organization of his General Staff, all reports go to him and directions go from him. Nothing is withheld that he desires to see. It is a type of organization in its completest form that is little adapted to a republican form of government in which civilian authority predominates and to which the military is subordinate, as provided in our Constitution.

In our Navy Department the organization of such a General Staff would be about as shown in Figure 1. In reality the Chief of the General Staff would sit at the head of the council table. The Secretary of the Navy would have no direct connection with his department or division heads, which we call Bureaus, and any information that would be given to the civilian Secretary would be only such as the General Staff would allow to come to him, the military control being in the hands of the Chief of the General Staff, the civilian Secretary being largely a figurehead. Such an organization in the complete form desired, as shown in Figure 1, is impossible under our existing laws.

Under Secretary of the Navy Meyer's administration an attempt was made to secure the nearest thing to a General Staff that could be obtained under the law. In order to develop his system, he divided the authority into four branches, called "Aids." As no single one of these were responsible for the whole, it resulted in divided responsibility and insufficient control. These "Aids," in order to comply with the requirements of the law, were proposed as advisory merely. They were actually, and necessarily so to make the organization work, executive. In reality, although called by another name, they were four divisions, departments, or superior bureaus, who directed the Fleet and the shore establishments through the Bureaus or in the Secretary's name, issuing these orders "by direction." The General Board, which was a nucleus of a General Staff established some time previous to this, was directly under the Secretary and not under the "Aids." The organization is shown diagrammatically in Figure 2.

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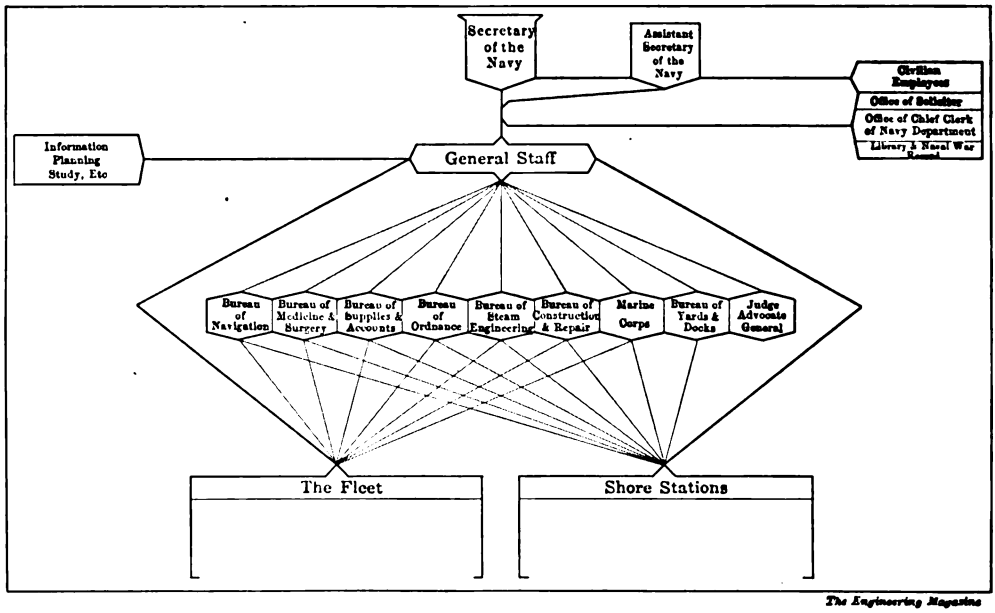

FIG. 1. AS OUR NAVY DEPARTMENT WOULD APPEAR IF OURS WERE A MONARCHICAL GOVERNMENT OF THE ABSOLUTE TYPE

Figure 3 shows the present organization of the Navy Department. The General Board reports directly to the Secretary, as shown by the broken line; but when the present Chairman of the Board, Admiral Dewey, is no longer able to perform these duties, it will report to the Chief of Naval Operations and engage in such special studies and plans for war as may

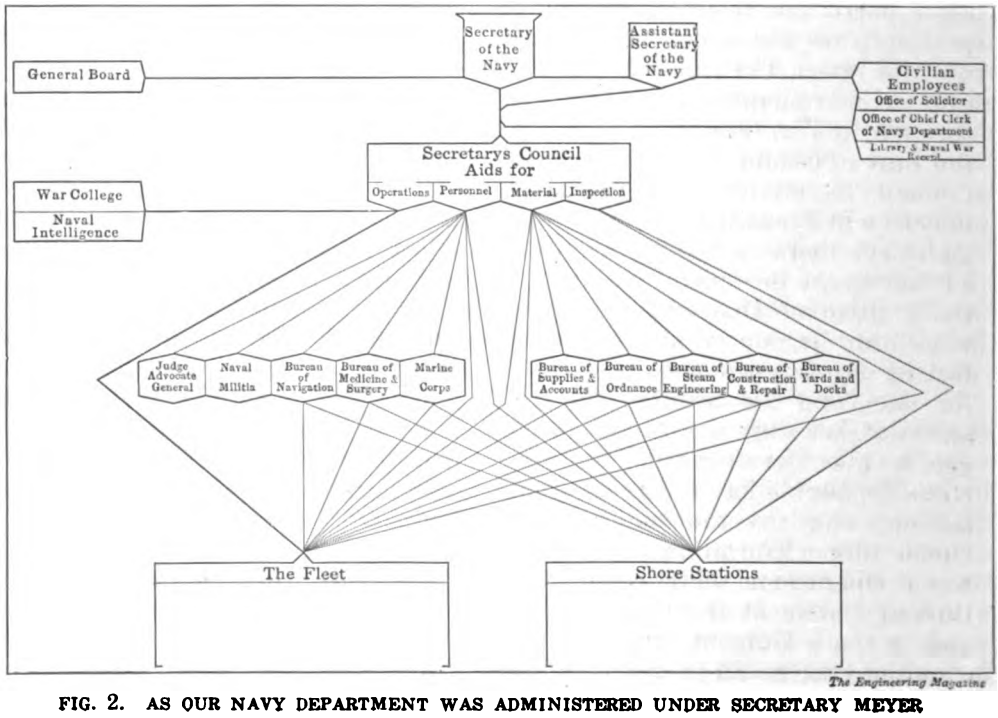

FIG. 2. AS OUR NAVY DEPARTMENT WAS ADMINISTERED UNDER SECRETARY MEYER

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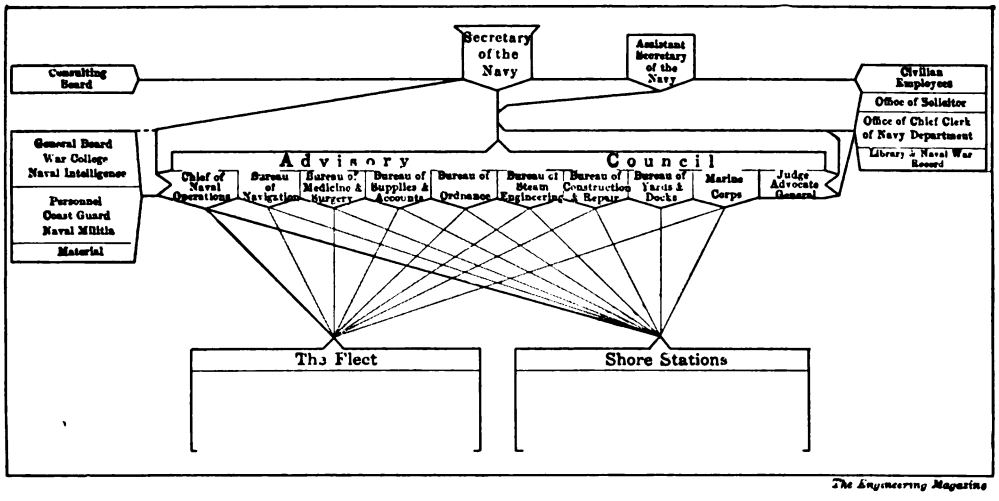

FIG. 3. OUR NAVY DEPARTMENT AS IT IS NOW ORGANIZED

be directed by the Chief of Operations. The Consulting Board is added, which advises the Secretary directly. Other than this he exercises control through his Advisory Council and the Bureau Chiefs who compose that Council, sitting at the head of his own Council Board where all matters come to him, if he desires them to do so, and all reports are received by him in person, if he wishes it. The business of the Department — that is, its executive functions—is transacted through the Advisory Council and the Bureau Chiefs which compose the Council. In addition to this Council, which while executive can also be advisory, there is a single military adviser to the Secretary, the Chief of the Bureau of Operations, who advises him directly on all matters affecting the studies and preparation for war, and the training for war, and watches through Naval intelligence the development of other Navies, possible flaws in their organization, and preparation for war. Under this organization the Chief of Naval Operations, while equal to the Bureau Chiefs at the Council Table and in the issuing of orders and instructions to the Fleet and shore stations, has in addition, which the Bureaus have not, a military advisory capacity. The Chief of Operations is responsible to the Secretary both for the operations of the Fleet and the efficiency of shore stations, and also for plans and studies of military campaigns. He advises also as to the future development and growth of the Fleet and shore stations, to co-ordinate with such schemes and military campaigns as may be laid down by it through the General Board and War College. The Assistant for Material under the Bureau of Operations does not, as this diagram well shows, control the technical Bureaus having to do with material. He merely studies and advises as to the future needs of material and makes observations in connection with such studies of the preparedness and workings of the material of the Fleet and shore stations in existence. He then reports and submits such criticisms of the existing material to the Chief of Naval Operations, who takes steps for improving it and correcting error directly with the individual Bureaus having to do with material, or with them and the Secretary of the Navy at the Advisory Council table.

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The line from the Chief of Naval Operations to the Fleet and shore stations has been made heavy to distinguish it from the lines from Bureaus to the Fleet and shore stations, to show that the orders and directions from the Chief of Naval Operations to the Fleet and shore stations would in each case be solely and directly with the Commanding Officers, but having to do with general military organization and operation, while the communication of the other Bureaus with the Fleet and with shore stations, although through the Commanding Officer in each case, would have to do with the special branch under that Commanding Officer of which the particular Bureau had charge and control.

The workings of the entire organization will be well illustrated by one example.

It is decided by the Secretary of the Navy, at an Advisory Council meeting, to place the entire Reserve Fleet at the Philadelphia Navy Yard in full commission, and have it join the Atlantic Fleet at some designated point. The decision is a military necessity and has been reached by the Secretary on advice of the Chief of Naval Operations after a conference with the Commander-in-Chief, the President. The Chief of Naval Operations issues the necessary instructions to the Commander-in-Chief of the Atlantic Fleet, to the Commandant of the Philadelphia Navy Yard, and the Commander of the Reserve Fleet. The Bureau of Navigation issues the necessary orders for detail and transfer of officers and men through the Commander-in-Chief of the Fleet, the Commandant of the Philadelphia Navy Yard, and the Commander of the Reserve Fleet. The Bureau of Medicine and Surgery issues the necessary instructions having to do with hygiene and medical supplies. The Bureau of Supplies and Accounts issues instructions and orders having to do with stores, supplies, and funds. The Bureaus of Ordnance, Steam Engineering, Construction and Repair, and Yards and Docks, each issue orders through similar channels, arranging for the necessary preparations for their specialties in material, as does the Commandant of the Marine Corps with respect to the Marine contingent.

The organization is logical and works smoothly. Its very simplicity is clearly shown graphically in the diagram, illustrating that an organization has been evolved, logical and simple, in compliance with the law and in no respect attempting to circumvent it. It has all of the advantages of a General Staff and none of its disadvantages and is entirely in keeping with a republican form of government, which permits of and makes possible the necessary civilian control of the entire naval organization.

It has been urged against the existing organization that the Chiefs of Bureaus, engrossed in and weighted down with routine work, could not spare the necessary time for the Advisory Council without seriously conflicting with the efficient operation of their Bureaus. This would undoubtedly be correct in an inefficiently organized Bureau, where the Chief of the Bureau permitted himself to be completely engrossed in the routine and detail of his work; but with a well-balanced organization, a Chief of Bureau with executive ability would free himself of much of the routine and detail, and reserve his time and energies for the broader and more important administrative functions of his office, the most important of which would certainly be that having to do with the general Advisory Council.

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NAVAL CONSULTING BOARD PERSONNEL

If the proof of the pudding be in the eating, the scheme adopted by Secretary Daniels for selecting the members of the Naval Consulting Board of the United States could not have been improved upon. Each of the eleven leading technical societies was constrained to put its best foot foremost, with splendid results.—THE EDITORS.

FOLLOWING are a series of brief accounts of the members of the Naval Consulting Board. The preponderence of electrical engineers, of chemists and of men with naval training is striking, as is the broad experience of all.

THOMAS ALVA EDISON

"WHEN it comes to Edison, we all take off our hats," thus a venerable and distinguished professor of chemistry. "He *sees* the solution of a problem that we have to attain with toilsome calculations and slow processes of reason." This voices the all but universal attitude of scientists and engineers the world over. Rarely is it given to a man so to impress his preëminence on the public and on the expert critics as well. And rarely is it given to a man so to identify himself with the industrial development of the world over his span of life. Scarcely a field of applied science in the last half-century that he has not tilled! The phonograph, the telephone, the incandescent bulb and the whole system of electric lighting, electric railways, telegraphy, the mimeograph, the fluoroscope, the storage battery, cement manufacture, wireless communication, motion pictures, the stock ticker, iron-ore beneficiation, rat and cockroach electrocutors, placer-gold saving, vertical writing and a host more; fifteen hundred patent applications taken out in his name!

It is hard to believe that his ancestry was Dutch. His electrical mind and furious energy seem foreign to the Lowlands. But perhaps in this inheritance lies the explanation of his infinite dogged patience in working out and perfecting his inventions, the persistence that spent $100,000 in sending men to every corner of the tropical earth to find just the right bamboo fiber for his lamps, the thoroughness that required 50,000 experiments for the development of his storage battery.

Born in Ohio 68 years ago, he compressed a wonderful variety of experience into the years of his youth. As a boy,—truck farmer, publisher, news agent, made deaf (he now counts this a blessing) by a wrathful conductor who threw him off the train when the phosphorus in his traveling laboratory set fire to the baggage car;—later, several years of wandering in the Middle West as a tramp telegrapher, then Boston and finally New York and its neighborhood, where he has lived ever since. A small, delicate child, he was almost drowned, almost smothered in a pile of grain, almost killed by a butting ram, almost run over while hauling a child from in front of a train; later risking his life time and again in his experiments; it is interesting to speculate just what America would have been today if Thomas Alva Edison had not lived to a ripe old age!

French in his brilliance, more than German in his thoroughness, he is totally and completely American in the application of his genius to practical ends, in his breadth of interest that includes the *Clipper* in his reading, and, like Lincoln, in his relish for hearing and telling a good story.

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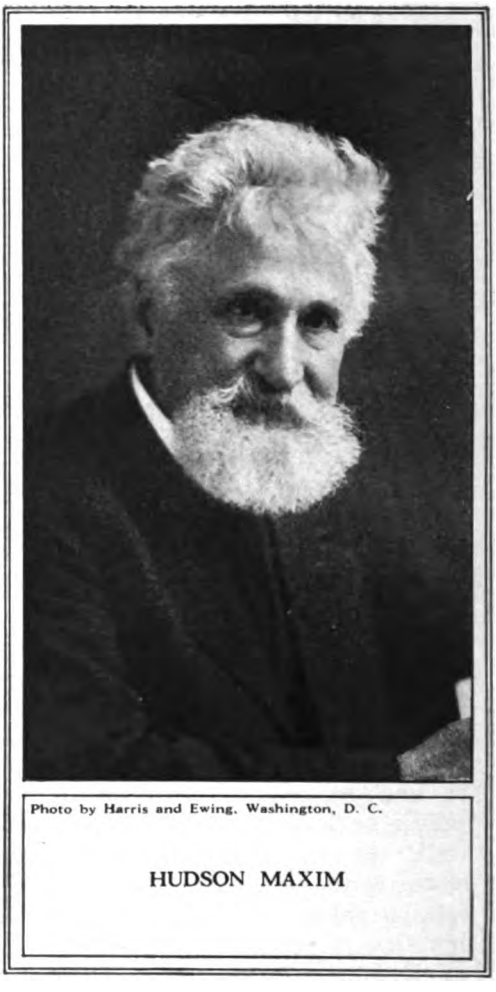
MATTHEW BACON SELLERS



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HUDSON MAXIM

AERONAUTICAL SOCIETY OF AMERICA

MATTHEW BACON SELLERS

MATTHEW BACON SELLERS brings to the Consulting Board an expert knowledge of aeronautics, together with a broad and cosmopolitan training in other directions, well calculated to give its possessor insight and balance. He is a native of Baltimore and received the greater part of his early training in the schools of that city. He spent a year, however, in the gymnasium at Göttingen, Germany, and another year at Eureux, France; the point of view developed in this foreign sojourn is likely to prove valuable to the Board and to the country.

He followed his preliminary education with a course at the Harvard Law School which graduated him with the degree of LL. B. He then changed from the law to applied science and took some special courses at Lawrence Scientific School and also at Drexel Institute.

For fifteen years he has been active in aeronautics; he was one of the first to determine the dynamic air pres-

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sure on arched surfaces by means of the "wind tunnels." His investigations in this direction he described in a paper read before the Aeronautic Congress at the St. Louis Exposition in September, 1904, and entitled "Lift and Drift of Arched Surfaces," and again in the *Scientific American Supplement* of November 14, 1908. He has written rather extensively, two others of his papers being, "Center of Pressure on Arched Surfaces" and "Notes on Interference of Aeroplane Surfaces," these being reports of further experiments with the wind tunnels.

His "stepped aeroplane" was a definite achievement; it is probably the lightest machine ever built that would fly and holds the record for the least horsepower requirements.

Mr. Sellers is a member, director and past-chairman of the technical board of the Aeronautical Society of America, is a member of the aerodynamic committee of the Aero Club of America, and is technical editor of *Aeronautics*.

Hudson Maxim

PERHAPS after Thomas Edison, the member of the Consulting Board best known to the public is Hudson Maxim. A man of brilliant intellect, he has cultivated many and diverse fields of science and art. High explosives particularly and aeronautics have claimed his attention. While selected for the Board by an aeronautical organization, he has done his best known and most effective work in developing high explosive compounds.

He was born at Orneville, Maine, in 1853 of English and French Huguenot descent. After work in the publishing line he turned to invention and experimentation about 1888. Soon after he built a powder mill in New Jersey and manufactured the first smokeless powder to be adopted by this Government. He sold mill, patents and his own expert knowledge to the Du Pont interests. Later he sold the Government the secret of his high explosive, Maximite, the first to be successfully used as the bursting charge in armor-piercing shells. Among others of his explosive inventions are a detonating fuse, also adopted by the Government, and Stabillite, a smokeless gunpowder which possesses the advantage of being available for use at once after manufacture.

An interesting explosive for a different purpose is Motorite, a substance made in long bars, designed to burn slowly and at a fixed rate, and convert admitted water into steam, which together with the hot gases of combustion is used for driving an engine. The substance is especially suited for propelling torpedoes.

Destructive materials have not been Mr. Maxim's only field of invention. He perfected a process for making calcium carbide continuously, which is now in general use in this country, and he invented a game of skill, called the War Game, resembling chess somewhat and based on the manoeuvers of troops in the field.

Hudson Maxim is a tireless worker and a prolific writer and takes a keen interest in public affairs. He is a prominent member of the Aeronautical Society of America, the Military Service Institution, the Society of Chemical Industry, the Chemists' Club, the Navy League, the American Association for the Advancement of Science, the New England Society, and the Aero Club of New York.

Like most experimenters with explosives, Maxim has had narrow escapes without number, but they have all been escapes, so far as his life is concerned. This is fortunate; for his knowledge of both aeronautics and explosives will be invaluable for the country.

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WILLIS R. WHITNEY

Photo by Falk

LEO HENDRIK BAEKELAND

AMERICAN CHEMICAL SOCIETY

WILLIS R. WHITNEY

IT is an old jibe flung at the graduates of the Massachusetts Institute of Technology by the captious and jealous graduates of rival schools that "you can always tell a Tech man, but you can't tell him much." In a non-invidious sense the statement comes pretty near to being true in regard to Doctor Willis R. Whitney. The director of the Research Laboratory of the General Electric Company has need to know about all there is to know in the provinces which that laboratory covers. The work of the laboratory is too well known to require extended description. It has been fruitful for science, profitable for the General Electric Company and beneficial to the country at large. No better example could be found of the mutual debit and credit account between pure science and philosophy on the one hand and applied science and industrial organization on the other. Each line of endeavor has contributed heavily to the other.

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Much of the work of the General Electric laboratory is not public property, but on the other hand much of it is. The metalized filament, the first radical improvement on the original Edison carbon filament for incandescent lamps, is to be credited to Whitney as director of the laboratory. There followed the solution of the mechanical problems in drawing tungsten, which made the tungsten lamp practicable commercially. Alloys, insulation compounds and other devices without number have been developed and perfected.

Doctor Whitney, born in Jamestown, N. Y., was graduated from Tech in 1890 and got his doctor's degree from Leipzig in 1896. Continuously since graduation he has been in the faculty of the Institute, advancing from assistant instructor to professor. He became associated with the General Electric several years ago and since 1900 has been director of the famous laboratory.

LEO HENDRIK BAEKELAND

IT is interesting to consider how very many of the Consulting Board members touch our every-day lives with their inventions and their processes. This is particularly true of Leo Hendrik Baekeland. When you buy a fountain pen with a transparent barrel, it is probably made of Bakelite, a material which Doctor Baekeland discovered. When you take your roll of films to be developed and printed, the chances are more than even that the prints will be on Velox paper, which Doctor Baekeland also brought out.

Born in Belgium in 1863, young Baekeland obtained an unusually thorough education in that country and in Germany. He was graduated from the University of Ghent in 1882; was laureate later of four Belgian universities; studied electrochemistry at the Charlottenburg, Germany, Polytechnicum; taught physics in the University of Ghent and physics and chemistry in the Government Higher Normal School of Science in Bruges; and in 1889 came to the United States to report on educational methods; this was fortunate for the United States.

On this trip he was consulted by A. and H. T. Anthony in regard to photographic films and papers, entered their employ for two years and then started out for himself in research and consultation work. In 1893 he founded the Nepera Chemical Company, making Velox paper and other photographic materials, and afterwards sold it to the Eastman company. He helped in developing the Townsend electrolytic cell for the Hooker Electrochemical Company and later became president of the General Bakelite Company, manufacturing his inventions.

Doctor Baekeland has received honors and medals in large quantity. He has been at various times awarded the Nichols medal by the American Chemical Society, the John Scott medal by the Franklin Institute, the Willard Gibbs medal by the American Chemical Society, Chicago section, and the Chandler gold medal by Columbia University. He was appointed delegate to the International Congress of Chemistry in London, 1909, and first Chandler Lecturer at Columbia University in 1914. He is fellow of the American Association for the Advancement of Science, member of the American Chemical Society, of the American Electrochemical Society, of the Society of Chemical Industry, of the American Institute of Chemical Engineers, and of the Inventors' Guild; he belongs to the Chemists' Club of New York, the University Club of New York and the Cosmos Club of Washington. He has occupied important offices in most of these organizations.

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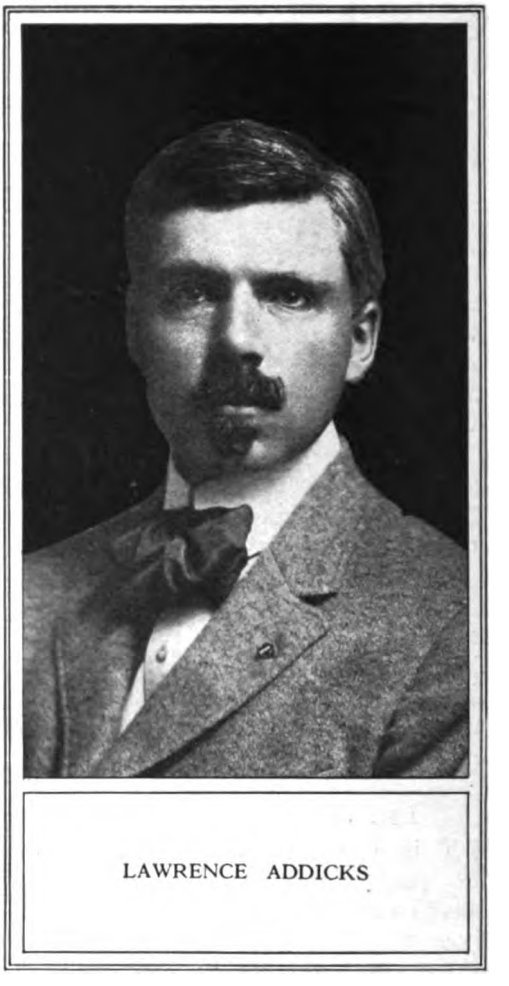
JOSEPH WILLIAM RICHARDS



LAWRENCE ADDICKS

AMERICAN ELECTROCHEMICAL SOCIETY

JOSEPH WILLIAM RICHARDS

ALL science and all knowledge seem at times to be based on chemistry. No other branch of inquiry so goes to the root of things. And chemistry in the last few years has been changing its aspects so rapidly that only specialists have been able to keep up with it. Physical chemistry, as it used to be called, is now about all the chemistry there is; recent profound modifications in the atomic theory have forced a reconstruction of the whole chemical edifice. Electro-chemistry is part and parcel of physical chemistry and it is most fitting that the American Electrochemical Society was invited to designate two members of the Consulting Board.

Joseph William Richards has been closely identified with the entire life-history of the science of electro-chemistry in this country. Born in England in 1864, he was reared in the atmosphere of applied chemistry; for his father was a manufacturing chemist in England and later became

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metallurgist of the Delaware Metal Refinery in Philadelphia. Joseph Richards, after his preparatory education in England, was graduated as analytical chemist from Lehigh University in 1886. He joined the faculty there, took a doctor's degree and then studied and traveled in Europe, spending some time at Heidelberg and Freiberg.

He was always intensely interested in the metallurgy of aluminum; when he was graduated from Lehigh his thesis was a resumé of the literature on that metal and an account of experiments conducted. This was revised several times and has become a standard work on the subject. He has written numerous other papers on the subject of aluminum and has been a frequent contributor to scientific societies and to technical periodicals. He is a member of the Franklin Institute, the American Chemical Society, the German Electro-Chemical Society, the American Institute of Mining Engineers, the Faraday Society (England), the Iron and Steel Institute (England) and the American Electrochemical Society.

Doctor Richards is still professor of metallurgy in Lehigh University and divides most of his time between that institution and the American Electrochemical Society. As secretary of the latter, he has worked always with energy and patience to bring it to the important place it now holds. In the American Institute of Mining Engineers he performed a vast amount of detailed constructive work, which was largely responsible for the renewed growth of that organization.

LAWRENCE ADDICKS

IF the formation of the Naval Consulting Board performs no other useful function, it will have been exceedingly beneficial in helping the people to distinguish between the "real ones" and the "advertisers." Engineers and technicians, the men on the firing lines of the several industries, know who is doing honest work and who is not. In the method of selecting the members of the Board, those most competent to judge have been consulted, and as a consequence many a case of highly deserving but inconspicuous success has become recognized.

Among the dark horses thus brought forward, Lawrence Addicks is prominent. His achievements and brilliant qualities have long been well known to mining engineers and metallurgists, but the public has heard little or nothing about him. But few men know more about copper than he and the importance of copper in warfare has been brought home by the present conflict as never before. Lawrence Addicks is a Tech graduate, taking his degree in 1899. The first years out of college he spent in roughing it in New Mexico, mostly in the vicinity of Silver City, where he did a good deal of miscellaneous mining. In 1901 he entered the metallurgical field definitely, engaging in research work at Raritan, New Jersey. From 1904 to 1906 he was in charge of the power plants and shops of the Delamar Copper Works at Chrome, now the United States Metals Refining Company, and for the next eight years he was superintendent of the plant. He then resigned and entered on some research work for Phelps-Dodge at Douglas, Arizona, in an attempt to solve the problem of a commercial leaching process for copper ores. He completed this work in August of this year.

Mr. Addicks belongs to the American Institute of Mining Engineers and the Mining and Metallurgical Society of America and is president of the American Electrochemical Society.

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FRANK JULIAN SPRAGUE

Photo by Pirie MacDonald

BENJAMIN G. LAMME

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

FRANK JULIAN SPRAGUE

FRANK JULIAN SPRAGUE, electrical engineer and ex-naval officer, was born in Milford, Connecticut, in 1857. He entered the Naval Academy in 1878 and served more or less for a few years, until the field of electrical invention drew him ashore and kept him there. In these days, when every fighting boat carries electrical equipment beyond enumeration and electrical propulsion is to be tried on the California, who could better have been selected for the Consulting Board!

Sprague early came under the spell of the new science of electricity and made several minor inventions while he was still with the Navy. Like most young fellows of his day with a bent toward experiment, he worked for a while with Edison. But a disagreement as to personal prerogative led to a parting. Sprague took up the development of the motor and it is with the successful use of electric motors on trolley cars and main-line locomotives that his name is most commonly associated. At Richmond, Virginia, he installed the pioneer

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trolley system; and he worked out the system of multiple-driving units for electrified roads. In vertical transportation, as well as in horizontal, he has solved many problems, developing high-speed screw elevators, automatic house elevators and double-motor-drum elevators and being now consulting engineer for the Otis Elevator Company. He is also consulting engineer of the General Electric and officer in numerous Sprague companies. He has been intimately concerned with the electrification of New York's terminals and is in general an adherent of the direct-current system, using, however, high voltages.

Mr. Sprague has had a bountiful supply of honorary medals and belongs to many technical organizations, among them, the American Institute of Electrical Engineers, the American Institute of Consulting Engineers, the New York Electrical Society, the Inventors' Guild, the American Society of Civil Engineers, the English Institutions of Civil Engineers and Electrical Engineers and the Society of Marine Engineers and Naval Architects. He also belongs to a series of clubs, including the University, Engineers and Bankers. He has never lost interest in the Navy and is now actively engaged with his son in the development of high-angle-fire shrapnel.

Benjamin G. Lamme

BENJAMIN G. LAMME was born and educated in Ohio. He was graduated from the State University in 1888 and ever since that time has been with the Westinghouse Electric and Manufacturing Company, entering the testing department, taking up design work, and becoming chief engineer in 1903.

Mr. Lamme has been a leader in the development of alternating-current apparatus, including the induction motor, rotary converters and single-phase railway apparatus. He has also been a pioneer in the development of the first direct-current apparatus for railway lighting and power work. As an electrical engineer he is known the world over, and is an exceedingly fertile inventor, having to his credit a large number of important patents.

To attempt to enumerate the achievements of Mr. Lamme in the electrical field is beyond the scope of this note. The high position which the Westinghouse company holds in the fields of power generation, transmission, utilization for industrial purposes, and the development of railway apparatus for interurban and trunk lines is largely due to the ability of Mr. Lamme.

Among the more important installations with which he has been identified may be mentioned the famous 5000-horsepower revolving field Niagara Falls generators, installed in 1895 and still in service with no radical changes from the original design. The design was new and contrary to the existing standard practice and the installation of the machines was against the advice of many famous engineers. Mr. Lamme was also concerned with the design and installation of the single-phase equipment for the New Haven electrification and the Philadelphia-Paoli electrification of the Pennsylvania.

Mr. Lamme is an unusually clear and interesting technical writer and is chairman of the board of editors of the *Electric Journal*. He takes great interest in the training and direction into the proper line of activities of promising young engineers. His selection by the American Institute of Electrical Engineers as one of two from among its ten thousand members is a high honor but one thoroughly deserved in every way.

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BENJAMIN BOWDITCH THAYER

Photo by Gessford

WILLIAM LAWRENCE SAUNDERS

AMERICAN INSTITUTE OF MINING ENGINEERS

BENJAMIN BOWDITCH THAYER

BENJAMIN BOWDITCH THAYER has been in great demand this fall. Fortunately for the Consulting Board, it secured his services before Mayor Mitchel found he needed him to pass judgment on the quality of the timbering in New York's subways, a matter which was worrying New York a great deal. Mr. Thayer could not help the Mayor out because he was too busy, partly with Anaconda affairs and partly with the Navy.

B. B. Thayer is a Native Son of the Golden West, being born in San Francisco, the birthplace of many a good mining man, in 1862. He came East, however, for most of his education, attending Adams Academy at Quincy, Mass., and Lawrence Scientific School; he took his degree from the latter in 1885 and went at once into the field. He went early to Butte and the Anaconda and also did some mining in California, New Mexico and Mexico. He was president of the Anaconda from 1908 till 1915, when

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it absorbed its own parent, the Amalgamated, and is now vice-president of the greater company.

He has polished the head of a drill and handled a muck stick in his time. He has worked in the stopes and has worked up out of them and could have given the subway engineers the best possible expert advice on their timbering methods. Technical knowledge and long practical experience are combined in him with rare executive ability and a personality that engages the affection and loyalty of his men to an extraordinary degree. Everybody on the Anaconda staff gets a square deal; there are few organizations in which professional jealousy between subordinate and superior and between different departments is so small; everybody works for the Anaconda. And the result is what might be expected; Anaconda smelting and Anaconda ore dressing are unrivalled in the world; the dazzling preëminence of American copper metallurgy, commercially and technically, is the work to a great extent of the Anaconda staff.

Mr. Thayer is one of the half-dozen pillars that support the American Institute of Mining Engineers. More exactly, he is one of the constructors that rebuilt the organization a few years ago and filled it with new life. He works hard for the Institute and rarely misses a meeting; and he works hard for Harvard, belonging to several Harvard clubs and being a member of the advisory committee on mining education. He belongs to a number of New York clubs, including the Union League and the Engineers, and of course to the Silver Bow Club of Butte.

Ben Thayer is a big man, mentally and physically. An immediate impression of tremendous ability, received on seeing him first, is confirmed and reinforced by more intimate acquaintance. On a broad foundation of detailed knowledge and skill he has built a solid structure of appreciation for basic facts and a wide outlook. He has been associated with big affairs for many years, an experience that should prove beyond price to the Navy. Out in Butte, where they know him best and love him most, they call him "Big Ben."

William Lawrence Saunders

WILLIAM LAWRENCE SAUNDERS was born in Columbus, Georgia, in 1856. He was graduated from the University of Pennsylvania in 1876 and did newspaper work for a while. He early evinced that taste for adventure that characterizes the mining engineer, by making two balloon ascensions, reaching a height of three and a half miles and remaining up all night.

His first engineering work of importance was along the water front of New York, work that involved rock excavation. His interest in rock-excavating problems led to his joining the Ingersoll Rock Drill Company and he has been associated with the Ingersoll company ever since. He is now Chairman of the Board of Directors of the Ingersoll-Rand Company.

Mr. Saunders has made a number of inventions and taken out patents. Among these are drilling and quarrying machines, channelers, and the Radialaxe coal cutter.

He belongs to many technical societies, including the Mining, Mechanical and Civil organizations and to many civic bodies. He is a good Democrat and has served twice as mayor of North Plainfield, New Jersey. He has written a number of books and has contributed numerous papers to periodicals and society proceedings, chiefly on rock drilling but also on economic questions. He is at present president of the American Institute of Mining Engineers.

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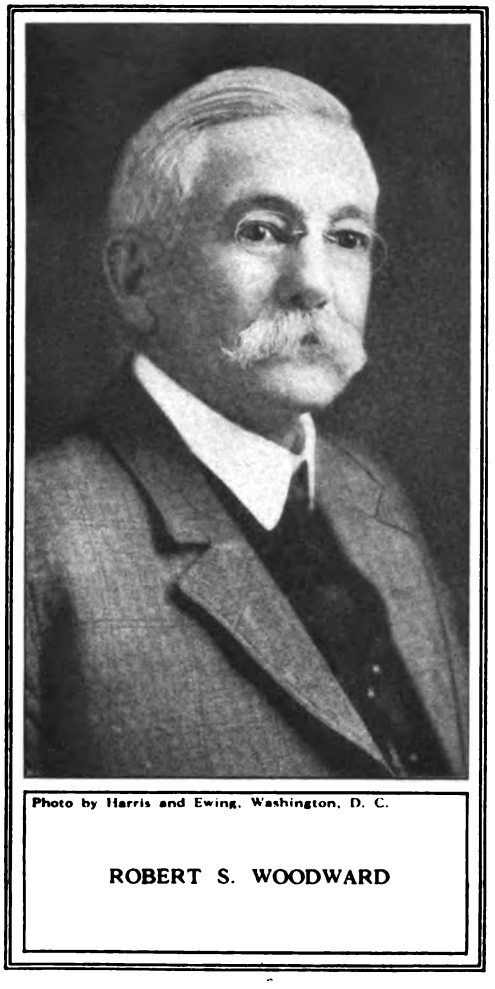

Photo by Harris and Ewing, Washington, D. C.

ROBERT S. WOODWARD

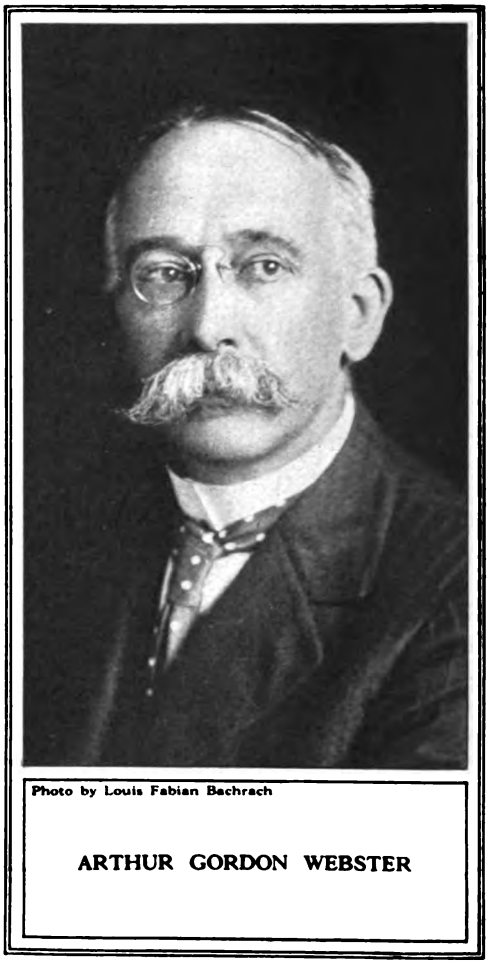

Photo by Louis Fabian Bachrach

ARTHUR GORDON WEBSTER

AMERICAN MATHEMATICAL SOCIETY

ROBERT SIMPSON WOODWARD

ROBERT SIMPSON WOODWARD is an illustrious mathematician with an engineer's training. Born at Rochester, Michigan, in 1849, he was graduated from the University of Michigan in 1872 with the degree of Civil Engineer. For twenty years thereafter he was engaged in geodetic and astronomic work with the Lake Survey, the Geological Survey and the Coast and Geodetic Survey, of the Government. In 1893 he was made professor of mechanics and mathematical physics at Columbia and in 1905 was appointed president of the Carnegie Institute, a position which he still holds.

Doctor Woodward has received many honorary degrees and has served as president of many scientific societies, namely, the American Mathematical Society, the American Association for the Advancement of Science, the New York Academy of Science and the Washington Philosophical Society. He is an authority on many phases of mathematical

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physics, such as the horizontal pendulum, the constant of gravitation, the mass of the earth's atmosphere, and the influence of the earth's rotation and spheroidal shape upon the deviation of a falling body from a vertical line.

The direction of the Carnegie Institution with its annual expenditure of close on a million dollars for scientific research involves a high degree of executive ability as well as a knowledge of pure and applied science, both intensive and extensive. In addition, Doctor Woodward possesses a keen insight into the character of men. The possession of these several qualities will make him a most valuable and reliable critic of the plans and inventions which may be submitted to the Board.

Doctor Woodward has a trenchant mind and positive convictions and is far from inarticulate. He is remembered with affection by his students as a doughty champion of the sciences against the so-called "cultural studies." As a professor he rarely lost an opportunity to break a lance with any critic of scientific courses and as rarely was he worsted. His vigor of manner and his peppery and fluent vocabulary were as serviceable in these contests as they were entertaining to his auditors. He may be depended upon to assert himself on the Board in the interests of sound doctrine and good methods.

ARTHUR GORDON WEBSTER

ARTHUR GORDON WEBSTER, physicist and mathematician, was born in Brookline, Massachusetts, in 1862, coming of a long line of New England ancestors. His early education was in the public schools of Newton and he was graduated from Harvard in 1885, at the head of a class of 190. After a year of instructing at that institution, he traveled for four years in Europe and studied at the universities of Berlin, Paris and Stockholm, receiving his doctor's degree from Berlin in 1890. Soon after Clark University was established in Worcester, Webster was made docent in physics and by 1900 had been advanced to be professor of physics, a position which he still holds.

Doctor Webster's work in physics has been directed along a number of different lines, some of the most important being electrical phenomena, acoustics and the gyroscope. His earliest work was on the ratio of the electrostatic and electro-magnetic units, this being the subject of his dissertation at Berlin. A rather distinguished success came to him when his study of the heat disengaged in the successive charges and discharges of condensers took first prize in the Paris competition in 1895, Oliver Lodge and R. T. Glazebrook receiving only second and third prizes, respectively. He has published other papers on electricity and magnetism, but his name is perhaps best associated with acoustics, a field of investigation which is only now being recognized in its true practical importance. Doctor Webster's task was to devise a suitable instrument for the measurement of energy in the form of sound waves. In this, his knowledge of the mathematical theory of sound and of the vibrations of plates, together with considerable mechanical ingenuity, resulted in developing an excellent instrument, and his studies of the efficiency of sound-producing agencies carried on with this instrument, made him the recognized authority in this branch of physics in the United States.

Two treatises of his, one on the theory of electricity and magnetism and the other on the dynamics of particles and of rigid, elastic and fluid bodies, are monumental works, only too rare in this country.

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ELMER A. SPERRY

HENRY A. WISE WOOD

AMERICAN SOCIETY OF AERONAUTIC ENGINEERS

ELMER AMBROSE SPERRY

ELMER AMBROSE SPERRY, famous for achievements in many lines of invention, comes of sturdy old New England stock. While he himself was born in Cortland, New York, in 1860, the first home of his family in this country was in Connecticut. His ancestor, Richard Sperry, was one of the early settlers from England in the New Haven colony. Richard is justly famous for having extended help to three of the judges who condemned Charles I to death and who were afterward pursued to this country by the officers of Charles II; they were hid in a cave on the Sperry farm and kept safe until pursuit died away.

Elmer Sperry spent a year at Cornell but received most of his education in the school of experience. Before he was 21 he had perfected one of the first arc lights, and founded an electrical - appliance manufacturing company in Chicago. In 1883 he erected on Lake Michigan the largest electric beacon in the world, 350 feet

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high and equipped with arc lights of 40,000 candlepower. He was the first to produce electrical mining machinery and later manufactured electric railway cars. He was identified with the early development of the automobile, patented storage batteries, invented a caustic soda and bleaching powder process, and developed a detinning method.

Perhaps his most distinctive work, however, and certainly that best known to the public, is his application of the principle of the gyroscope to practical ends. Nearly every United States battleship and submarine is equipped with the Sperry Gyro-Compass; hundreds of aeroplanes carry the Sperry Aeroplane Stabilizer, and a number of vessels are equipped with the Sperry Ship Stabilizer.

He has received numerous medals and awards for his inventions, such as the John Scott medal from the Franklin Institute, a 50,000 franc prize from the Aero Club of France and the Collier Trophy from the Aero Club of America. He is president of the Sperry Gyroscope Company of Brooklyn, is a member of the American Institute of Electrical Engineers, the Electrochemical Society, the American Society of Mechanical Engineers, the American Chemical Society, the Society of Naval Architects and Marine Engineers, the Aero Club of America and the Engineers Club.

His varied experience and his versatility fit him peculiarly well for the duties of a member of the Naval Board, while it is evident to the most casual that his intimate knowledge of the gyroscope will prove of incomparable value in mapping plans of national defense.

Henry A. Wise Wood

HENRY A. WISE WOOD was born in New York City in 1865. His father was Fernando Wood, mayor of the city for three terms, and his ancestry dates back to early colonial times, being both Quaker and Dutch. Mr. Wood was given a complete scientific training in his early years and was to have completed his engineering education abroad had not his father's death led him to enter the business of manufacturing printing machinery.

The mechanical and engineering side of the art of printing has engaged his interest ever since and he has done brilliant work in the improvement of stereotyping processes. Two of his inventions have increased fifteen fold the rate at which type may be multiplied in impressions upon paper.

He has been devoted for years to the study of mechanical flight but has made it his recreation rather than his business. He has furthered the science of aeronautics and promoted its interests in every way and his study of the subject has made him a recognized expert in the field.

He has taken especial interest in water flying and has advocated its development both as a sport and for its value in military and naval art. He has in fact always kept in close touch with Naval affairs and is keenly interested in increasing the efficiency of our fleet. He has, furthermore, made a close study of the question of our merchant marine.

Mr. Wood is president of the American Society of Aeronautic Engineers, vice-president of the Aero Club of America and editor-in-chief of *Flying*, a periodical which he founded together with Robert Collier and Henry Woodhouse in 1911. He is also a member of the Society of Naval Architects and Marine Engineers, the American Society for the Advancement of Science, the American Geographical Society and the New York Yacht Club.

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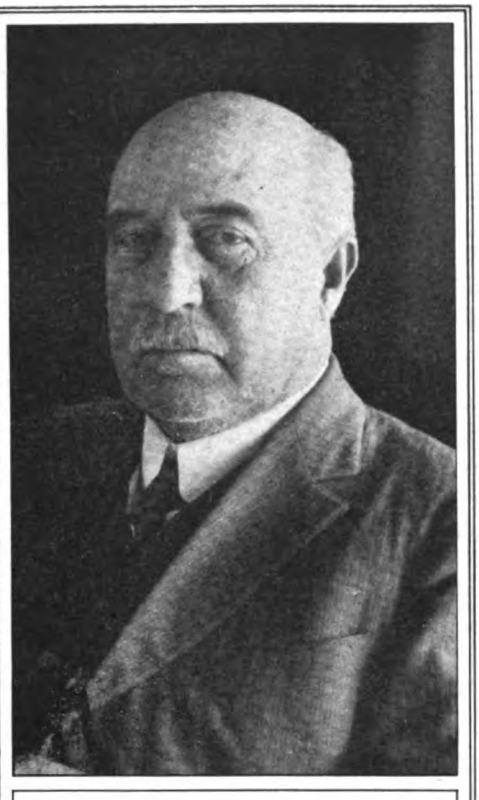
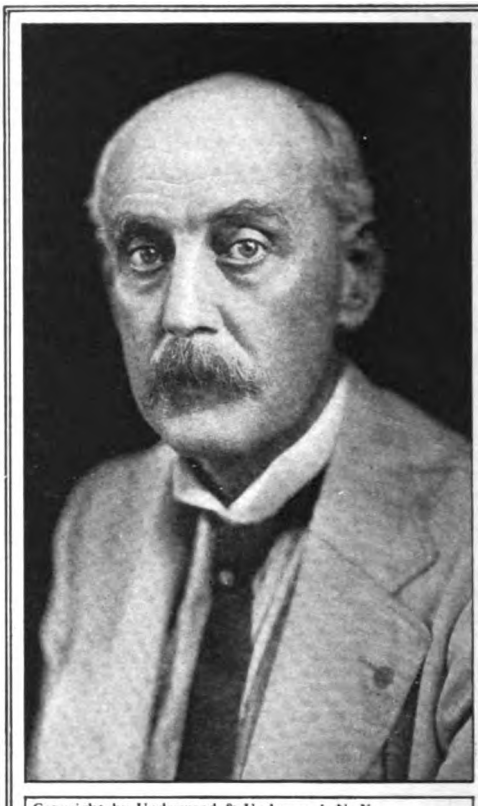


ALFRED CRAVEN



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ANDREW MURRAY HUNT

AMERICAN SOCIETY OF CIVIL ENGINEERS

ALFRED CRAVEN

IF the Consulting Board was intended, as it is said, to be recruited from men of large affairs, the selection of Alfred Craven was most happy. As head of the New York subway engineering staff and practically in supreme charge of the work, he has manifested a grasp of detail and a scope of vision that marks him as a man of extraordinary ability. His fitness for the Board is further attested by the fact that he comes of Naval stock. His father was Rear-Admiral Thomas T. Craven, who served through the Civil War and was afterward commandant of the Mare Island Navy Yard, and Alfred himself is an Annapolis graduate.

Alfred Craven was born at Bound Brook, New Jersey, in 1846. He was graduated from the Naval Academy in 1867 and after a few years' service he retired while on the Pacific Coast and joined the California Geological Survey. He did some irrigating engineering work and was associated with prominent mining engi-

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neers on the Comstock, notably with Alfred Sutro in the construction of the famous Sutro Tunnel. In 1884 he joined the staff of engineers of the new Croton Aqueduct and continued in Aqueduct work until 1900.

On this work he estabished a splendid reputation for rugged honesty. In 1900 he entered the service of the Rapid Transit Commission on subway construction work and was put in charge of the section which included Forty-Second Street, and Broadway to 104th Street. This involved the delicate and difficult excavation under the Times Building. He held increasingly important positions under the Commission until he became chief engineer, in 1910, of the Public Service Commission.

Mr. Craven's forty-five years of experience in many parts of the country and in many different lines of work has adequately demonstrated his capacity as an engineer and as an executive. It has also gained him an enviable reputation as a peacemaker and arbiter of the many complex questions that arise in the construction of an underground transit system through a great city. As a witness at hearings before the Commission and before the courts he has won the respect and admiration of leaders in many walks of life. Lawyers, financiers, and commissioners join in testimony to the extent and depth of his professional knowledge and still more to his ability to present it.

Andrew Murray Hunt

ANDREW MURRAY HUNT, born in Sioux City, Iowa, in 1859, received his early education in the common schools of that city and of Indianapolis. He was appointed to the Naval Academy and was graduated from that institution in 1879. He served for fifteen years in the Navy in various capacities and in 1894 resigned his commission to engage in consulting engineering work on the Pacific Coast. Since that date he has been identified with the engineering activities of the Coast in widely varied lines. His work has included hydro-electric developments, irrigation, steam power plants, gas plants, oil refineries, cement manufacturing plants, heavy acid plants and other construction.

One of the ablest men in his class at Annapolis, soon after graduation he established his reputation as a worker and investigator and a leader among the younger men of the Engineering Corps. He was a member of the Board of Steel Inspection when that body filled an important place in the building of the New Navy. Just before leaving the Navy he was chief of the Department of Machinery at the Mid-Winter Fair in San Francisco in 1893-4. It may be added that he consented to fill the same place at the Panama-Pacific Exposition until it was well organized, when he stepped aside in favor of his chief assistant.

His engineering work has shown originality and courage and he has always enjoyed the absolute confidence of his clients. He built a fleet of steamers for the Yukon on that river, because the type needed would not stand the ocean voyage. Such a feat, to those who know anything of Alaska, tells its own story. On another occasion he was given authority to make the design and contracts for a large central station when he had only had time for a rough estimate, so great was his client's confidence in his judgment and business acumen.

It is hardly going too far to say that in recent years he has been the leading engineer on the Pacific Coast. Several times he has tried to retire but his friends insist that he alone can do the particular work that they have in hand.

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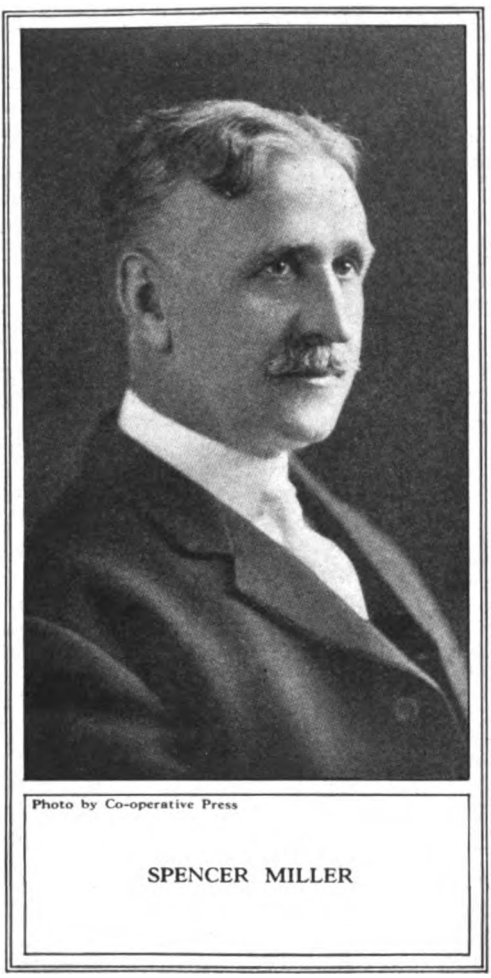

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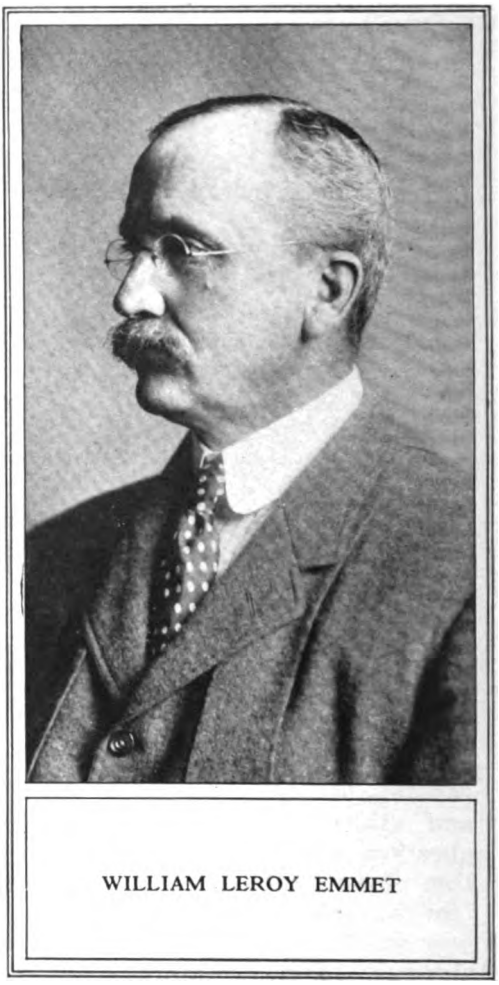
SPENCER MILLER



WILLIAM LEROY EMMET

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

WILLIAM LEROY EMMET

TO many of the members of the Naval Consulting Board, the work will be only a return to the field of their earlier labors, for almost half-a-dozen are Annapolis graduates and served for some time in the Navy. This is true of William Le Roy Emmet, who was born in Pelham, New York, in 1859 of Irish descent and was graduated from the Naval Academy in 1881. He served for a year or two and re-entered the service at the time of the Spanish War. His reputation has been won in the field of electrical machinery and steam turbines.

He has been associated with both the Sprague and the General Electric companies, has made numerous inventions and taken out many patents, while contributing to the development of the industry in many less definite but no less important ways. His most important lines of endeavor have been the development of the alternating

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current for general use and of the alternating-current machines involved, and the perfection of the steam turbine as a prime mover. He designed and directed the development of the Curtis turbine by the General Electric Company, a work which involved a tremendous amount of detail and was carried through with almost unprecedented speed.

One of his most significant pieces of work was the design of the machinery for the first ships driven by electricity. The success of electric propulsion on the collier Jupiter is likely to prove epoch-making in the history of marine transportation.

Mr. Emmet is also to be credited with the invention of several types of transformers, of several details of alternators, of the oil switch and of the varnished cambric cable. He is the inventor of the vertical-shaft steam turbine and of several details of turbine design. He was responsible for most of the later, most successful and largest work of the Niagara Falls Power Company.

Mr. Emmet has written extensively and is a member of several organizations, among them the American Philosophical Society, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the Society of Naval Architects and Marine Engineers.

Spencer Miller

In the field of hoisting and conveying machinery, Spencer Miller is the acknowledged leader; it was his inventive genius that made possible the modern cableway. Born in Waukegan, Illinois, in 1859, he was graduated from the Worcester Polytechnic Institute in 1879 and soon entered the employ of the Link-Belt Conveyor Company. About twenty-five years ago he became associated with the Lidgerwood Manufacturing Company and the success of that company in the design and erection of cableways and loading systems is a history of Mr. Miller's work. He devised the "button-stop" fall-rope system, and applied it to the Lidgerwood cableways with the result that the company's products were soon in demand all over the world.

An interesting example of Mr. Miller's successful coping with difficult conditions is the scheme he devised for cypress logging in the Louisiana swamps. He cut the cost of logging by over 50 per cent and added an untold amount to the value of the timbered areas.

His most important work from the point of view of the new position to which he has been called on the Board is his solution of the problems of coaling ships. Early in the Spanish War, his company was called upon to solve the question of coaling at sea, and as a result Mr. Miller designed a cableway that made it possible to transport coal from ship to ship while both were under headway. The capacity of this device is now 80 tons an hour; it is used by Great Britain, Japan, Russia and Italy in addition to this country. For coaling in harbor, Mr. Miller's system of "broadside" handling has increased the capacity per hatch from 25 tons per hour to 100, while one man now does the work of 80. Another marine invention of Mr. Miller's is his breeches buoy cableway apparatus with which the Revenue Cutter Service is now equipped and which makes it possible to maintain tension automatically while passengers are transferred from ship to ship in even the heaviest seas.

Mr. Miller belongs to the organizations of the Civil Engineers, the Mining Engineers, the Mechanical Engineers and the Naval Architects and Marine Engineers.

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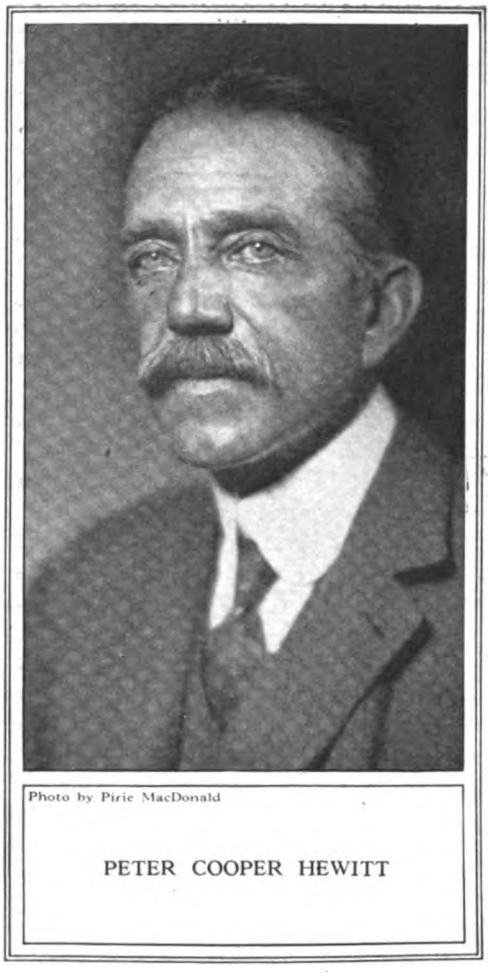

Photo by Pirie MacDonald

PETER COOPER HEWITT

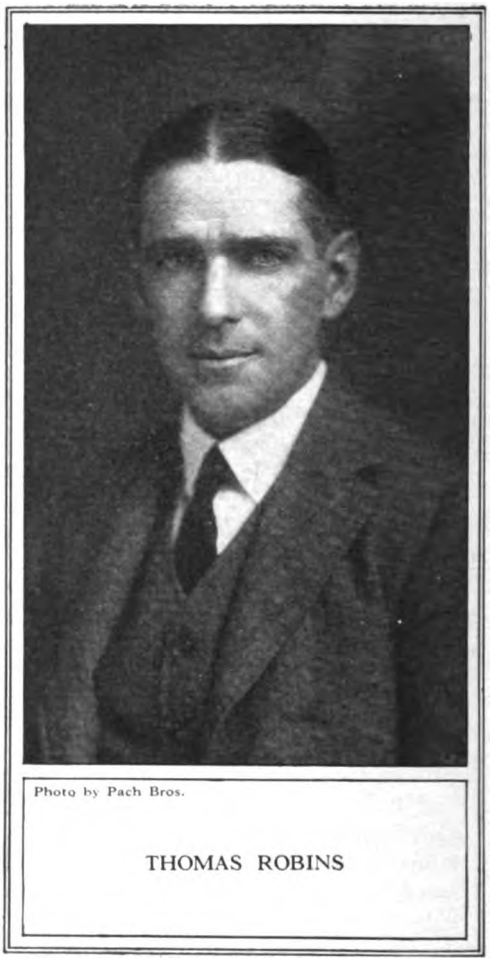

Photo by Pach Bros.

THOMAS ROBINS

INVENTORS' GUILD

PETER COOPER HEWITT

PETER COOPER HEWITT is best known for his electric lamp and his rectifier, but he has made many other inventions in the electrical field including some concerned with radio-communication and has also conducted a series of experiments in the relations between moving plane surfaces and fluids such as air or water. He was born in New York in 1861 and was educated at Stevens and Columbia. He evidenced early his genius for mechanics and scientific investigation by improving the machinery in his father's glue factory.

He first began to devote serious attention to the electrical field in 1898. His mercury-vapor light, a successful attempt to improve on the inefficient incandescent, is widely known; approximating cold light, as it does, its efficiency and actinic intensity make it peculiarly useful in certain kinds of lighting such as in shops and in pho-

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tographic studios. His rectifier or converter for alternating currents opened up a whole new field of electric applications. His electric interrupter can be used either in place of a switch or in connection with one for turning off high-tension currents and also for producing the high-tension impulses used in wireless work; its silence, speed, uniformity and strength make it exceedingly useful. His wireless receiver for detecting signals is unequaled for sensitiveness and is very rugged. Finally, his electric-wave amplifier for feeble telephone currents completes a list of five electrical inventions of fundamental importance to the industry.

Mr. Hewitt has devoted a great amount of study to the phenomena of plane surfaces moving in water or air, such as propellant blades or lifting vanes. As a result of his investigations he built one of the first hydroplane motor boats and conducted with it some highly successful tests as regards speed and power. Naturally he has given much attention to the subject of aeroplanes.

Mr. Hewitt is a member of the American Institute of Electrical Engineers, the American Physical Society, the Society of Naval Architects and Marine Engineers, the Inventors' Guild, the Illuminating Engineering Society, the Institute of Radio Engineers, the National Institute of Social Sciences and many others.

Thomas Robins

THOMAS ROBINS was born at West Point, New York, on September 1, 1868. He is the ninth generation in descent from Col. Obedience Robins, who settled on the Eastern Shore of Virginia in 1621 and was a member of the Governor's Council. It is possibly because his ancestors have always lived an amphibious, sea-coast life, first in Virginia and later in Maryland, that Mr. Robins is deeply interested in nautical matters. In the matter of inheritance also, there was a Thomas Robins, Midshipman in the Navy of the United States as far back as 1800, and a Lieutenant William Bowdoin Robins was given a sword by Congress for the part he played in McDonough's victory. Mr. Robins himself served seven years in the New York Naval Militia.

Mr. Robins was educated at Princeton, entering in 1886 and leaving college to go into the manufacture of rubber in 1889. He soon became interested in technical matters, and in 1891 commenced his development of the belt-conveyor. In 1896 he founded the Robins Conveying Belt Co., of which he is President. Mr. Robins has always expressed a heavy indebtedness to Mr. Edison for his kindness in permitting him to carry on at his plant a long series of experiments in testing the resistance to abrasion of various materials. The methods employed by Mr. Robins in these experiments were as simple as they were original, and this combination of characteristics may be found in a majority of his inventions, which pertain not only to the transportation of materials but to processes and machinery used in rubber manufacture, in bicycles, and electrical devices.

While according to his own statement Mr. Robins is "not a real engineer, never having understood mathematics," it is nevertheless a fact that his sound sense of proportion enables him to quickly detect an error either in a structural design or in a financial statement, and his sympathy with engineering is so strong and vital as to evoke from his assistants work of which the scope and originality is not easily surpassed, and while disclaiming mathematical ability, he has at least pointed the way towards the construction of many engineering formulas.

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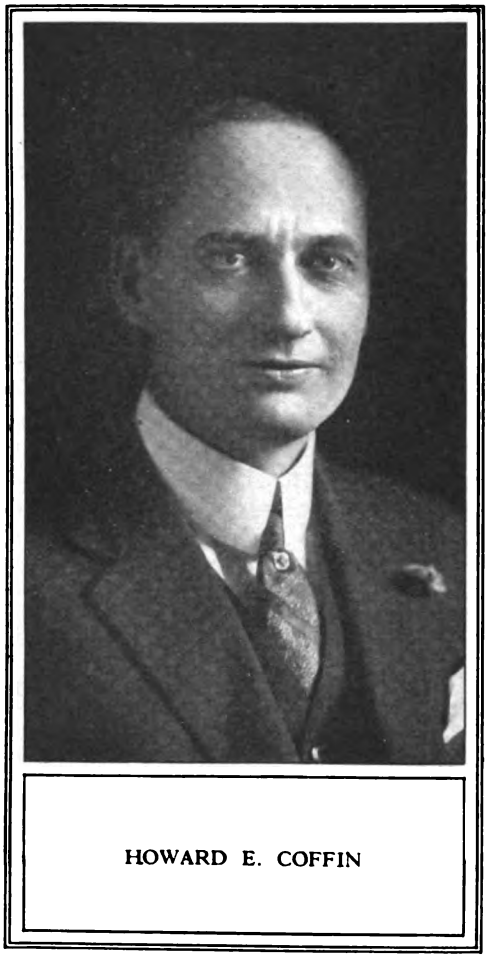
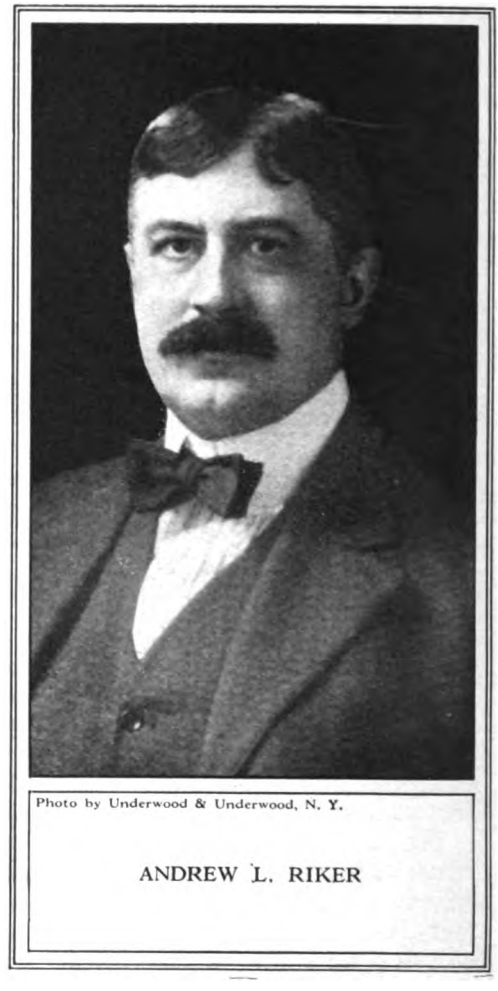


HOWARD E. COFFIN



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ANDREW L. RIKER

SOCIETY OF AUTOMOBILE ENGINEERS

ANDREW L. RIKER

IT would seem peculiarly fitting for two reasons that the Naval Consulting Board should have among its members two automobile engineers. The first reason is that the war now raging has shown the value of the light motor car and of the motor truck in military operations to be what even enthusiasts had not before suspected; the multitude of uses that have been developed for these high-speed, reliable conveyances is astounding. The second reason is that the progress of automobile manufacture has revolutionized mechanical engineering. In details of mechanism, in refinements of design and execution which save weight and space, in quantity production, in the development of invaluable alloys of steel and other metals, the automobile engineers have set a pace that would have been thought impossible a few years ago. The part to be played, therefore, by automobile engineers on the Consulting Board is sufficiently obvious even to the uninitiated.

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The two engineers selected to represent the profession on the Board are exceedingly happy choices. Andrew L. Riker has been associated with different phases of the industry for many years and has an intimate knowledge of both the mechanical and the electrical problems involved in automobile design and manufacture. He was the first president of the Society of Automobile Engineers and served three terms.

Mr. Riker early devoted his attention to the design of electric motors for vehicle propulsion and the Riker Electric Motor Company produced the first toothed armature. The first electric vehicle of this company was brought out in 1894; others that went into service in 1898 are believed to be still in use. By 1900 Mr. Riker was building five-ton electric trucks.

For thirteen years Mr. Riker has been vice-president of the Locomobile Company of America. In 1906 he built racing cars under the old 1000-kilogram weight limit; these were equipped with four-cylinder motors having 7½-inch bores and 6-inch strokes. One of them frequently attained a speed of 100 miles an hour and won the Vanderbilt Cup race in 1908.

Mr. Riker has done work outside the automobile field also. In 1890 he built the lightest and most compact lighting plant then available for marine work. He has taken out many patents on gas engines, dynamos, motors, electric systems, transformers and automobile parts.

Howard E. Coffin

AFTER Henry Ford, the man in the automobile industry best known to the public at large is unquestionably Howard E. Coffin. Mr. Coffin's reputation, however, rests on a much more secure foundation than mere popular acclaim. He is one of the keenest and most broad-minded automobile engineers in the country. Technical ability in design and business acumen and foresight are combined in him to an extraordinary degree. His eminent availability for the Consulting Board is beyond question.

Mr. Coffin received his education in the engineering department of the University of Michigan, but served for five years in the postal service of the United States; he is a splendid example of the best type of self-made American. He has been connected with the manufacture of a whole series of the best-known makes of American cars. From 1902 to 1905 he was chief of the experimental department and chief engineer of the Olds Motor Works. In 1906 he was vice-president and chief engineer of the E. R. Thomas Detroit Company and consulting engineer of the E. R. Thomas Motor Company. Subsequently he became chief engineer of the Chalmers-Detroit Company and the Chalmers Motor Company. He is at present vice-president of the Hudson Motor Car Company. He produced a steam-propelled automobile while the industry was still very young and has taken a leading part always in design and invention.

Perhaps his most significant work has been in the campaign for standardization and coöperation between manufacturers, in which he has been closely associated with Mr. Riker. They were directing officials of the Mechanical Branch of the Association of Licensed Automobile Manufacturers whose work begun about ten years ago placed the American automobile on a meritorious world-wide basis. Mr. Coffin, like Mr. Riker, has been president of the Society of Automobile Engineers, and has always been strongly identified with the work of the Society, particularly in the matter of promulgating mechanical standards and the simplification of methods.

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HANDLING MATERIALS IN MANUFACTURING PLANTS

By Robert L. Streeter

I. LOCOMOTIVE, GANTRY, MAGNET, AND SPECIAL CRANES

In this series, beginning in this issue, Professor Streeter will take up the mechanical handling of material from the point of entry of the raw material in the manufacturing establishment to the point of shipment of the finished product. He will describe, as far as possible, all the devices which contribute to the movement of material. This first chapter discusses heavy unloading equipment. Next month's subject will be Traveling and Stationary Cranes. Following chapters will be: Conveyors; Hoists and Elevators; Trucks; and Carrier Systems.—THE EDITORS.

HANDLING materials in all kinds of manufacturing plants is one of the largest problems and one most difficult to solve that confront the managers of our industrial organizations. The cost of handling materials is not often a large percentage of the total cost of production of a manufactured article, but it forms an item on which enough money can be spent uselessly to turn the tide from profit to loss, from solvency to bankruptcy. Consequently, the cost of unloading, loading, conveying, hoisting, etc., is one on which a great deal of study may be profitably spent.

It does not always require an expert engineer nor a high-priced specialist to find the leaks in the handling department. Oftentimes a little "sensible management" will work wonders. Not many years ago there was a tendency to look upon "first cost" as the governing item when a system of conveying machinery was to be installed. The writer has in mind a certain rolling mill in which there was a shear to crop off the ends of the eight by eight-inch blooms as they came from the blooming mill. The pieces cut off, weighing from 150 to 200 pounds each, dropped down to the ground level; to load them into cars two men grasped them with tongs, dragged them up an incline to a level of the car top, then tossed them over into the car. This mill worked day and night, six days a week. During the 24 hours there were about 1,000 pieces cut off by the shear. The work of taking away the crop ends was so severe that three men were on duty all the time, two working and one resting. Thus six men working in twelve hour shifts were required to load the waste from the shear, the labor cost being at least ten hours a day.

The above instance is cited, not in a spirit of criticism, but to show one place in which an investigation might well be made to determine the cost of installing and operating a machine to do the work. It is possible that such an investigation had been made and the results obtained showed that when the mill was built the conditions existing made the arrangement used entirely satisfactory.

Any proposition of handling material must be investigated carefully before it can be ascertained what system would be best adapted to the needs of that particular place. If an existing system is doing the work, adequate cost data can be easily obtained. If a new proposition comes up, a competent adviser should be consulted about the various machines

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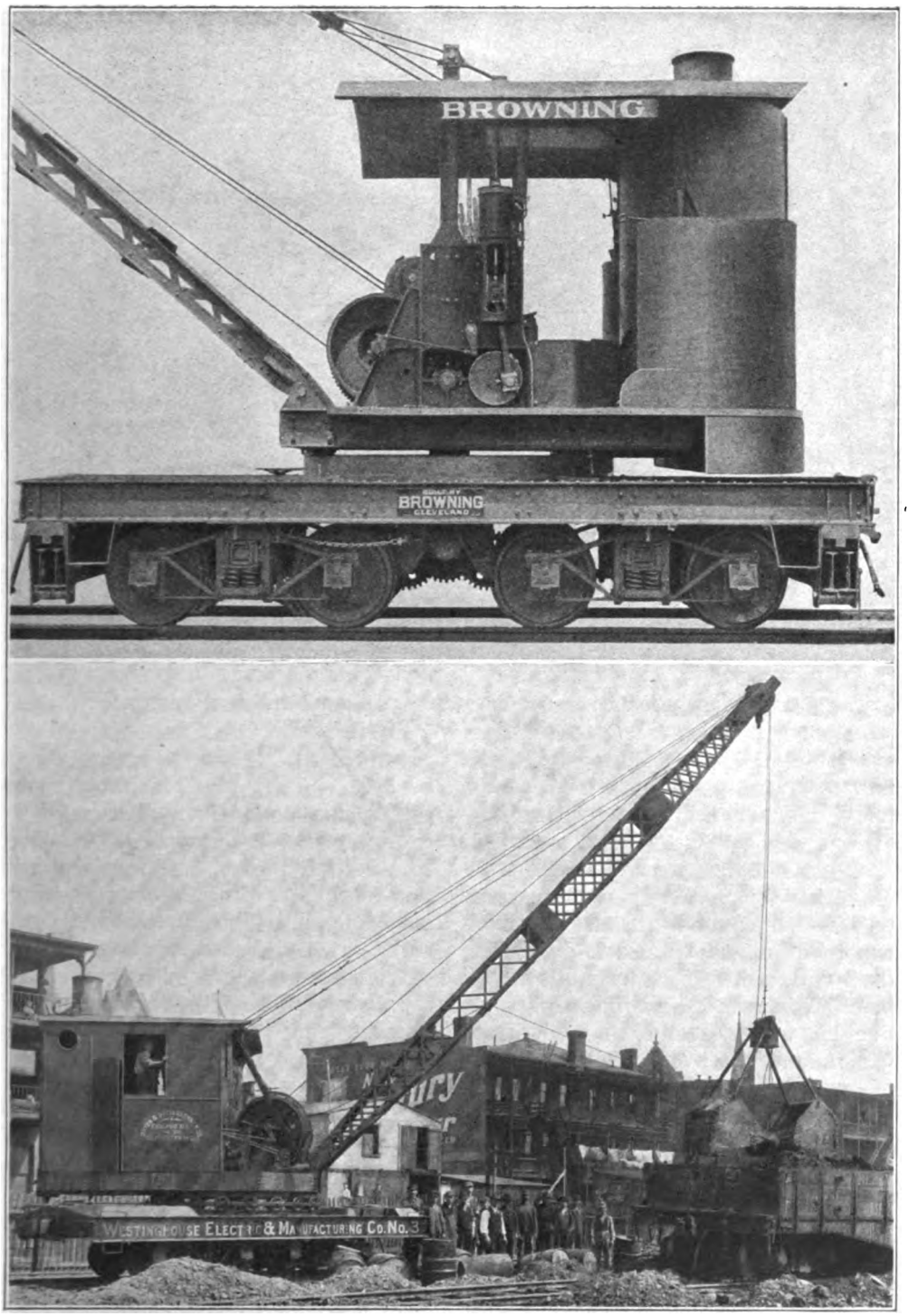

FIGS. 1 AND 2. TYPICAL LOCOMOTIVE CRANES

Above is depicted a Browning Crane, showing the usual construction and mounting. Below is a view of an Orton and Steinbrenner crane unloading coal from a freight car

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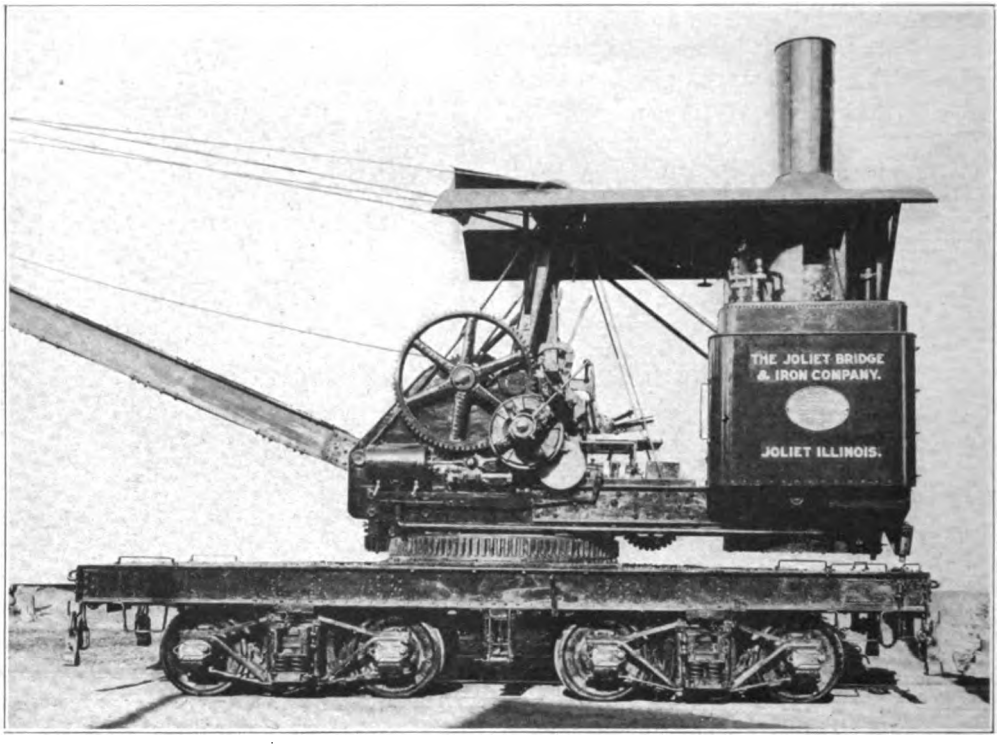

FIG. 3. CONSTRUCTION AND SETTING OF THE CRANE BUILT BY THE INDUSTRIAL WORKS, BAY CITY, MICHIGAN

available and their fitness for the work. Intelligent selection can be made only when all the existing conditions are considered and a careful analysis of each is made.

In this series of papers the writer will not endeavor to discuss the various questions that arise to determine the availability of different types of machines for a given piece of work, but he will describe and illustrate various machines for different classes of work in handling materials and give costs of doing the work where such costs are available. This paper will deal entirely with machines suitable for loading and unloading materials from railway cars and boats at manufacturing plants. The succeeding papers will take up the question of handling materials during the process of manufacture. Instead of trying to describe and discuss the different types of machines used in given plants the writer thought it best to classify the machines themselves and confine the discussion in each paper to a certain classification. The second paper, for instance, will take up traveling and stationary cranes applied to shop work; the third paper will discuss various kinds of conveyors; the fourth, hoists and elevators; the fifth, all kinds of trucks; and the sixth, carrier systems and special machines.

LOCOMOTIVE CRANES

This type of crane, as the name implies, is mobile and self-propelling. The power used for locomotion is also used for handling the loads. This power may be steam, electricity, or an internal combustion engine. The last named is not well adapted for such service and is used only in rare cases. When cranes are operated by electricity the power is taken from a trolley, third rail, or flexible cable

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running from a plug in the stations.

Locomotive cranes are ordinarily mounted on standard gage trucks with either four or eight wheels. For light cranes four wheels are sufficient, but heavy types require eight. Railway cranes that are moved in trains usually have eight wheels, as do cranes that are used for switching cars. In some special cases the track gage of the crane is greater than the standard of 4 feet 8½ inches. This is often the case where the crane is used to lift heavy loads within a limited area. The obvious advantage of the broad gage crane is that it can lift heavier loads at right angles to the track than the standard gage.

The body of the crane is usually made of steel. It carries a turntable rack on which are mounted the boiler and engine in case of a steam crane, or the motors in case of an electric crane. In addition there are the boom and hoisting drums, clutches, brakes, etc., used for propelling the car, slewing the upper structure, and operating the various lift and control lines.

While it is obviously impossible to describe in detail all the cranes made by different manufacturers, it might be well to go somewhat into detail with a few types. The crane shown in Figure 1 is made by The Browning Company of Cleveland, Ohio. The car body is built of steel shapes around a large center casting, while the crane built by Orton and Steinbrenner, illustrated in Figure 2, has a car body built of structural steel, the spaces being filled in with reinforced concrete.

Locomotive cranes are generally moved in either direction along the track by a clutch and train of gearing which transmits power from the main engine. Since the engine is on a turntable that swings on a pivot, the only way to transmit the power

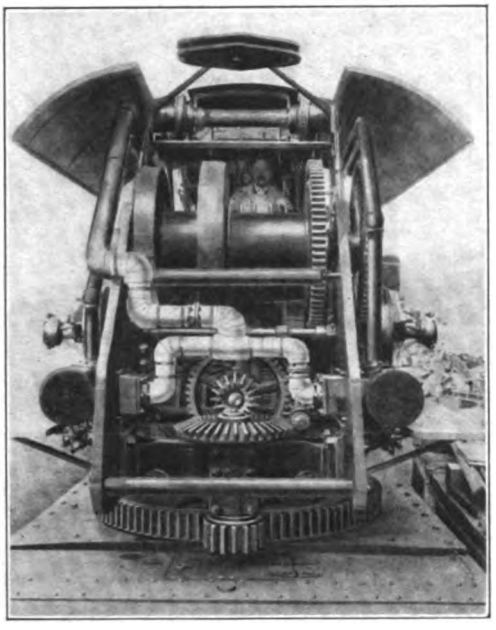

FIG. 4. 30-TON BUCKET LOCOMOTIVE CRANE WITH BOOM REMOVED
Industrial Works, Bay City, Mich.

to the wheels is by means of a vertical shaft through this pivot. This vertical shaft carries at its lower end a bevel pinion that meshes with a bevel gear on a short cross-shaft which also carries a spur pinion. This pinion drives the axle gears through idlers which are clearly shown in Figure 1. The axle gears of eight-wheel cranes are in line only when the crane is on a straight track; hence, provision must be made for proper meshing of the gears when the crane is rounding a curve. This is done by making the teeth of the idler gears with curved faces, the curves being arcs of a circle which have the pivot pin of the crane for a center. In some cases, where it is desired, the axles of each truck are connected by chains running over sprockets so that all eight wheels are driving wheels. On four-wheel cranes all the wheels are driven by means of bevel gears.

Four-wheel cranes are usually fur-

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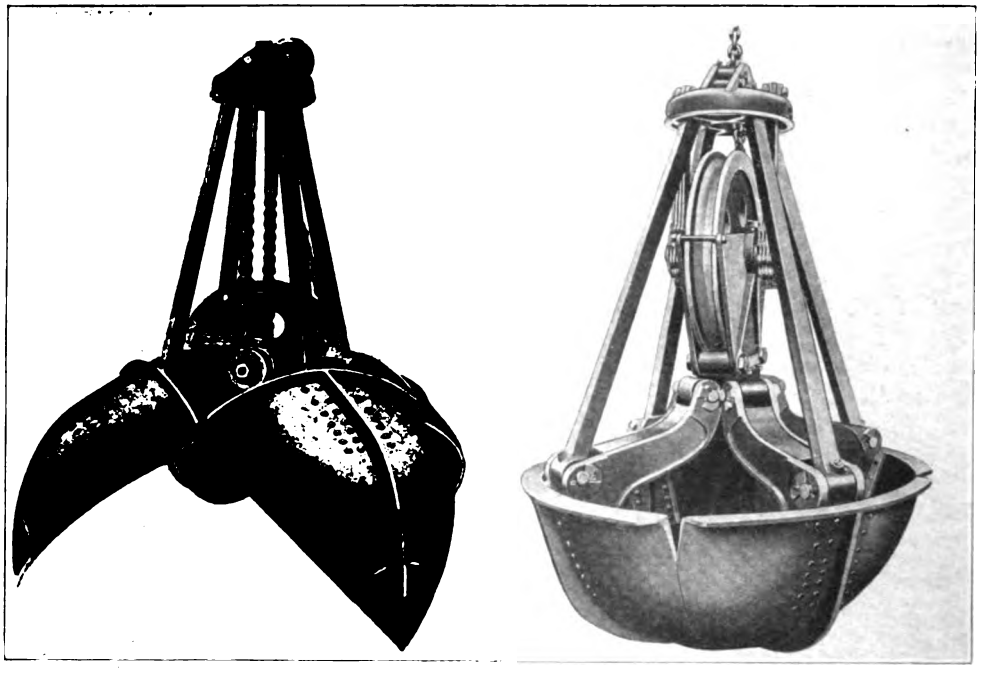

FIGS. 5 AND 6. ORTON AND STEINBRENNER ORANGE-PEEL BUCKET OPEN AND CLOSED
The points of the scroop of this type of bucket penetrate readily into the material to be removed

nished with wheels 24 inches in diameter, while the eight-wheel cranes have larger wheels, about 33 inches in diameter. The former type is fitted with a bull nose and long drawbar link, while the latter type is equipped with M. C. B. couplers. All cranes are fitted with hand brakes and the eight-wheel type is equipped with a through air pipe to be used when the crane is hauled in a train. If desired the cranes are equipped with steam or air brakes. Heavy cranes used in industrial plants and for yard work usually have steam brakes as they are much simpler than those operated by air. Railroad cranes that are often taken from place to place in trains should be, and usually are, equipped with air brakes.

Locomotive cranes may be equipped with rotating clutches or a separate rotating engine, which ever is desired. If the clutch system is used, two are provided when a reversing engine is used, so that the crane may be slewed either way by the clutches and a train of spur and bevel gears, the direction of motion being independent of the direction in which the main hoisting engine is running. The rotating engine, if used, is of the double, valve reversing type. It makes the rotating and hoisting operations independent of each other and puts the crane in better control of the operator.

Hoisting the load is usually accomplished by a train of spur gears controlled by a clutch and driving a bronze bushed drum which runs free on its shaft. Suspending and lowering the load is governed by a brake band on the drum which is operated by a combined hand and foot lever. Safely lowering heavy loads is further assured by operating against steam pressure, when the hoisting engine is reversible.

For bucket work, in the Browning crane, where one cable is required to close a hoist and a second cable to

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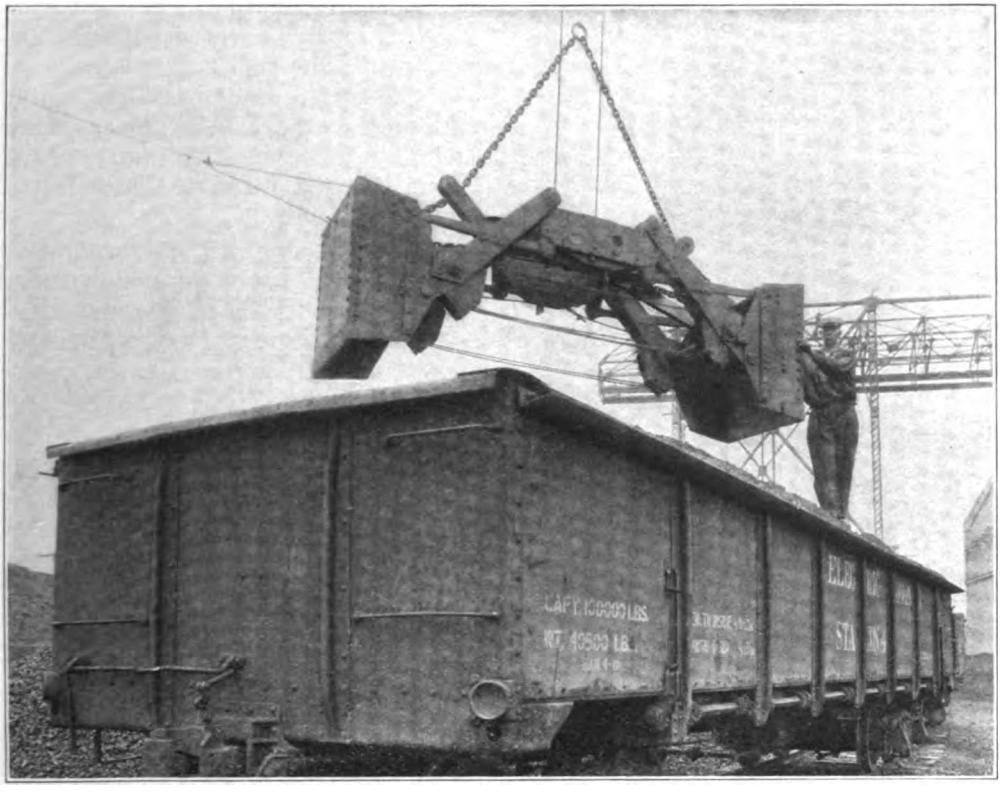

FIG. 7. ORTON AND STEINBRENNER ONE-YARD CLAM-SHELL BUCKET OPEN
These buckets are more serviceable in handling loose material than the orange peel

open and lower the bucket, an auxiliary drum is mounted on the same shaft with the main drum. The auxiliary drum is controlled by a fibre friction between the two drums and by a hand brake. The function of this friction is to make the auxiliary drum revolve with the main drum while hoisting, or, in other words, to take up and prevent slack in the cable. A combined foot and hand lever controls both the friction and the brake band of this auxiliary drum, so that when the brake is on the friction is off, and vice versa. When the brake is applied to open the bucket the friction against the main drum is automatically released, allowing the bucket to overhaul the hoisting cable quickly and thereby open without the necessity of reversing the engine. As only the clutch lever on the hoisting drum is used in bucket work and the brake and friction of the auxiliary drum are controlled by one lever, the bucket is handled entirely by two levers. If the crane is to be used for drag-line bucket or pile-driving work, both drums are made power driven. However, if the operator desires, one drum can be quickly disconnected from its clutch and the above described main and auxiliary drum and lever arrangement established.

To allow the load being handled at varying distances the boom of a locomotive crane is raised or lowered by a train of gears and a worm wheel operated by applying a clutch and running the main engine. The boom is held in position by the worm gear, but an automatic locking device is also furnished to make it impossible

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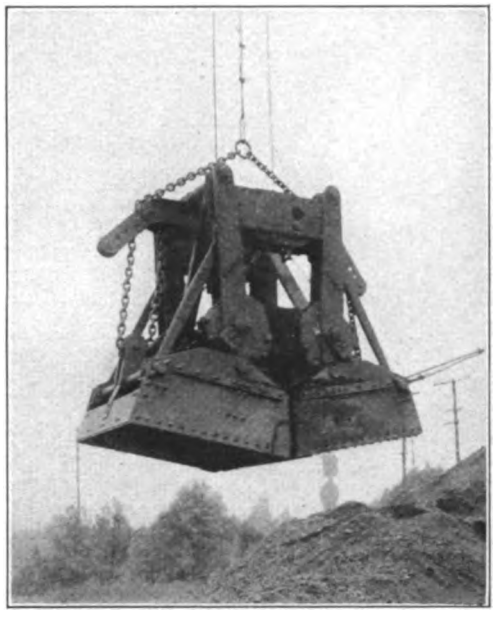

FIG. 8. ONE-YARD CLAM-SHELL BUCKET CLOSED

for the boom to fall. The booms on different cranes may be of different lengths. Long booms are generally made up of angle bars and plates, while shorter ones may be made up of channels. Special booms are sometimes furnished for special work. Usually straight booms are used, but it is often better to have booms with curved ends, especially where loads must be lifted over high obstructions.

Boilers furnished with locomotive cranes are of the vertical type with straight tubes. The size of the boiler depends on the capacity of the crane, but may be increased when steam must be furnished for other purposes than operating the crane proper. When a lifting magnet is used in places where electric current is not available, a small generating set is placed on the crane and this requires additional steam. When the crane is handling a steam pile driver the boiler must be large enough to furnish steam for the pile driver cylinder.

The boilers of all cranes are lagged, usually with block asbestos which is in turn covered with galvanized iron. The fuel box is located on one side of the boiler and the water tank on the other. In localities where fuel oil is less expensive than coal the crane may be fitted to burn liquid fuel.

The main engines of locomotive cranes are always of the two-cylinder twin type with cranks ninety degrees apart. There is no uniformity, however, when it comes to the question of whether the engine shall be reversing or non-reversing, horizontal or vertical. The Browning crane has a vertical engine which is reversed by means of a link motion, while the engine of the Orton and Steinbrenner crane is of the double, horizontal, non-reversing type, and that of the Industrial Works crane, illustrated in Figures 3 and 4, is of the horizontal reversing type. Naturally, the size of the engine depends on the capacity of the crane, the range being roughly from 7 by 10 inches to 12 by 12 inches. Boilers to correspond would vary from 42 inches to 62 inches in diameter. With boilers and engines of the sizes given above traveling speeds would be from four to eight miles per hour, slewing from three to six revolutions per minute, and hoisting from 100 to 250 feet per minute with a single line and 50 to 100 feet per minute with a heavy load. The specifications for a 15-ton Industrial crane call for a speed of 56 feet per minute with a maximum load using a three-part hoist, and 170 feet per minute with a five-ton load using a single line.

Locomotive cranes are built as standard in sizes from 5 to 60 tons capacity. Usually the smaller cranes, from 5 to 15 tons, have four wheels, while those with capacities of 15 tons and larger have eight wheels. Some companies build the 15-ton crane

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FIG. 9. SELF-PROPELLED BROWNING CRANE LOADING A MOTOR TRUCK WITH SAND
When manufacturing plants have to carry materials any distance, motor trucks may be used to good advantage, provided they are loaded and unloaded quickly

with both four and eight wheels. Ordinarily the standard track gage of 4 feet 8½ inches is used, but some companies build standard cranes with gages of 8, 12, and 16 feet. It is obvious that the broader the gage the greater will be the capacity of the crane at right angles to the track.

In speaking of the capacity of a locomotive crane it is not sufficient to give the load lifted, but the radius of lifting must also be given. Usually the rated capacity of a crane is the load it will lift at a radius of twelve feet at right angles to the track without the use of auxiliaries, such as rail clamps, out-riggers, or jack-beams. Some of the 50 and 60-ton cranes will not lift their rated load at 12 feet without the use of the out-riggers or jack-beams. In any case the capacity decreases as the radius increases, not because of lack of strength in the machinery of the crane, but because the crane would be over balanced if large loads were attempted. This necessitates the use of contrivances to hold the crane to the track or to furnish a bearing out some distance from the track.

A few figures are given here to show the variation of capacity of Industrial cranes when the radius of the load increases. The 25-ton crane will lift 50,000 pounds at a radius of 12 feet, 38,300 pounds at 15 feet, and 26,200 pounds at 20 feet, with a gradually diminishing load as the radius increases until at a radius of 40 feet the allowable load is 10,000 pounds. These figures are without jack-beams. With jack-beams the capacity is the same at 12 feet, but averages 4,000 pounds more than without jack-beams at the larger radii. The heavier cranes can lift much greater loads with the jack-beams than without. The 40-ton crane has a normal capacity of 14,000 pounds at a radius of 40 feet, while the capacity at the same radius with jack-beams is 23,000 pounds.

The great advantage of locomotive cranes over some other types of load-

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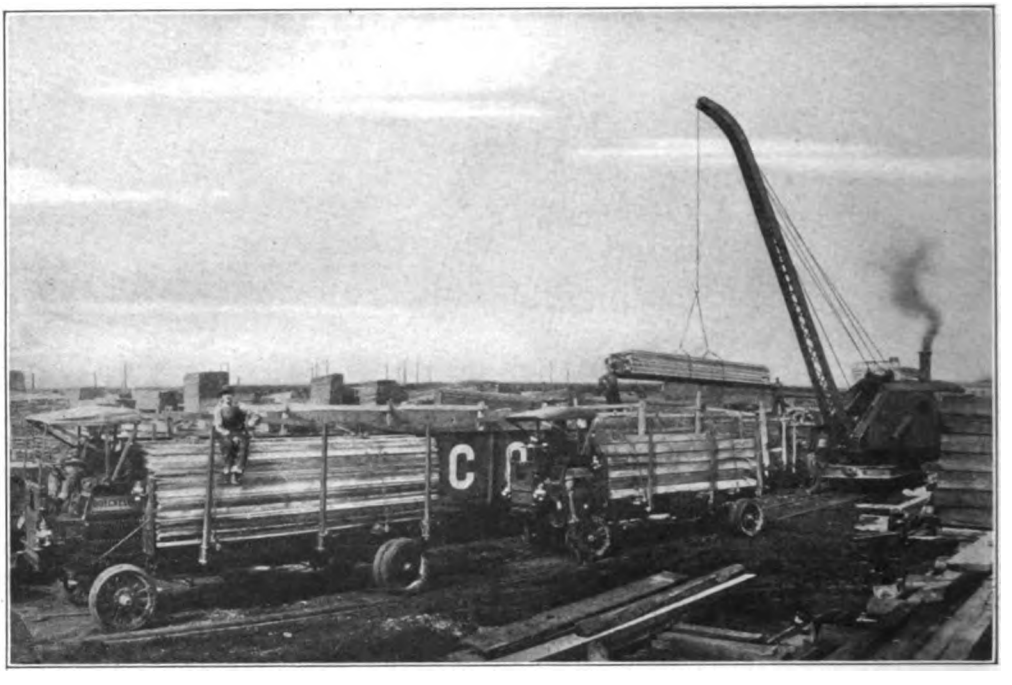

FIG. 10. TEN TON INDUSTRIAL CRANE, WITH CURVED BOOM, LOADING TRUCKS WITH LUMBER
Another case showing the application of a locomotive crane for loading motor trucks

ing and unloading machines is due to the fact that they can be made use of in so many different ways. In general all sizes of locomotive cranes do the same kind of work, the amounts of work done being limited by the capacities of the cranes. The heavier cranes, from 25 to 60 tons capacity, are used largely for erection work. The 40-, 30-, and 25-ton cranes are used also for bucket and magnet work when large amounts of material are to be handled. Cranes for pile driving work are usually from 20 to 40 tons capacity to hold the weight of the leaders, pile, and hammer at the radius of driving. The smaller cranes, with capacities from 5 to 20 tons, are, in general, used for all kinds of lifting, loading, and placing material. With a bucket they are invaluable for handling coal, ore, ashes, cinders, gravel, or any similar material in bulk; with skips and tubs they place concrete in forms, carry rock, etc. Equipped with a magnet they handle scrap, pig iron, sheets, and rails, as well as nails, bolts, screws, and similar material in kegs or boxes. When equipped with a hook and chain they are used for general yard work; to load and pile logs, ties, poles, and lumber; to place machinery, and for light construction work. Equipped with a steam-shovel dipper-arm they are available for excavating, grading, and ditching. The cranes shown in this article illustrate clearly some of the many places where locomotive cranes may be used profitably.

When locomotive cranes are used for excavation work, the form of the bucket is usually that illustrated in Figures 5 and 6 which show the Orton and Steinbrenner orange-peel bucket open and closed. This type of bucket is used because the points of the scoops penetrate the material much more readily than the edges of other buckets, such as the clam-shell. The greater part of the wear is con-

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centrated on the points of these scoops and, hence, they must be well protected. In this case the points are of manganese steel riveted to the scoops. These buckets are made in ten sizes ranging from one-half cubic yard to five cubic yards capacity. The weight of the smallest is 2300 pounds and has a height of 7 feet open, while the weight of the largest is 19,000 pounds with a height of 14 feet 11 inches open.

For handling ore, sand, limestone, and other loose material a clam-shell bucket may be used to a better advantage than the orange-peel type. The clam-shell is illustrated in Figures 7 and 8, which show a one-yard Orton and Steinbrenner bucket in the open and closed positions respectively. This bucket is built in nine sizes ranging from one cubic yard to ten cubic yards capacity, the weights varying from 3200 to 18,000 pounds. The spread of the jaws when open is 11 feet in the one-yard bucket and 23 feet 9 inches in the ten-yard bucket. The heights closed are 6 feet 5½ inches and 13 feet 10½ inches respectively for the smallest and largest sizes.

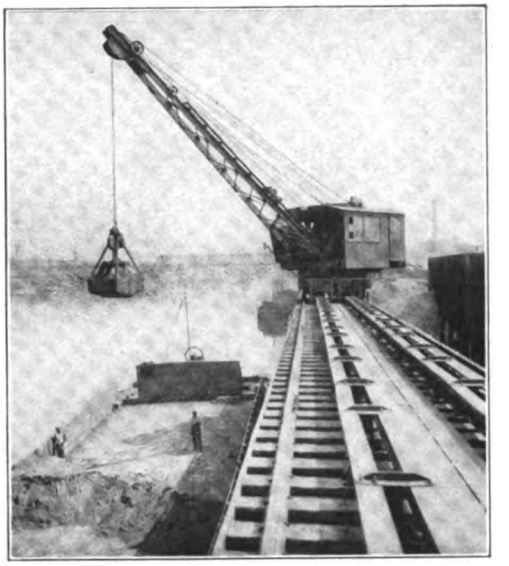

FIG. 11. WIDE-GAGE ELECTRIC LOCOMOTIVE CRANE UNLOADING SAND FROM BARGE
Link-Belt Company, Chicago

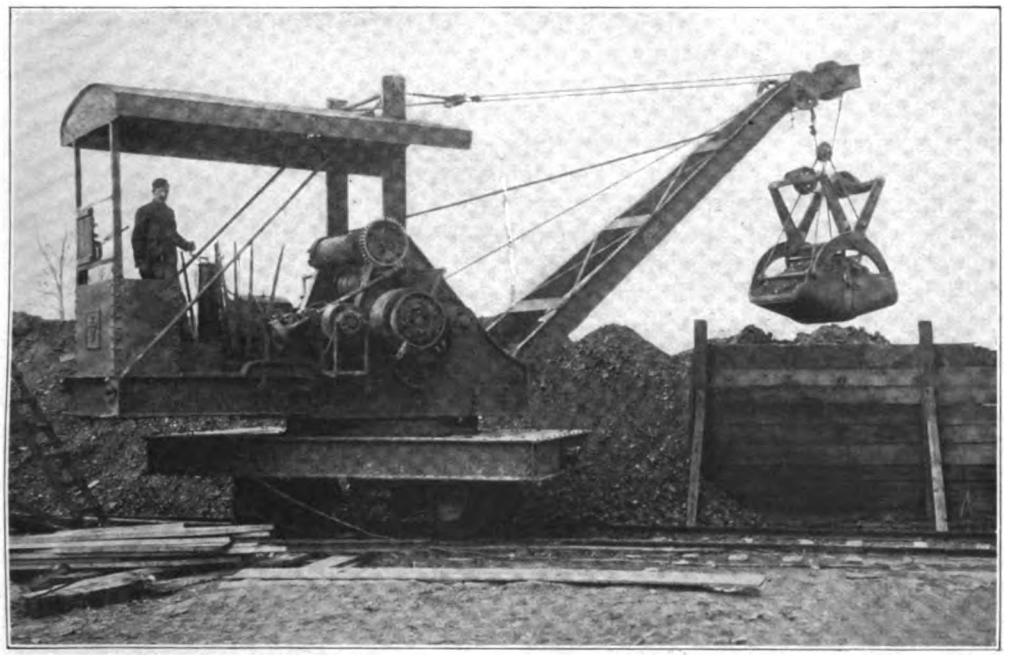

FIG. 12. SMALL ELECTRIC CRANE AND BUCKET HANDLING BITUMINOUS COAL
Northern Engineering Works, Detroit

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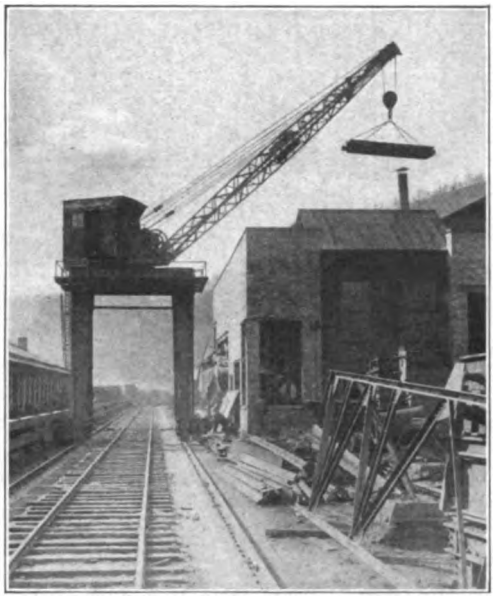

FIG. 13. BROWNHOIST PORTAL-PIER LOCOMOTIVE CRANE

Used for handling raw material to and from storage yard and mill. The cars run beneath the crane which has all the functions of a locomotive crane

It would be very difficult to give any accurate information about the cost of doing general work with locomotive cranes. The reason for this is that on different classes of work the cost per unit of work done would vary greatly, and not only this, but the same kind of work in different localities would vary in cost. For example, it would cost more for crane to unload coal into the roof bunkers of a boiler house than it would for the same crane to unload coal upon the ground or into low storage bins. A writer in *Railway Age Gazette* of July 15, 1915, says: "Experience has shown that a reasonably good operator can average one trip per minute with a locomotive crane handling a bucket or a magnet. In some cases this average can be raised to as high as five trips per minute. The daily cost of operating an eight-wheel crane varies from eight to nine dollars per ten hours, including depreciation, six per cent interest on the investment, and all operating costs. This estimate is figured on 300 working days per year. The cranes are ordinarily operated by one man who also fires the boiler, the number of men on the ground depending, of course, on the class of work handled. Investigation on the Illinois Central indicates that the average cost of maintenance is about $600 per crane per year."

In the August number of *Sugar*, Mr. James Shearer gives the cost of handling coal and sugar beets at three different plants. In each case the cost is given per ton and the time per car.

Plant 1. Coal—Cost by hand 8 cents, by crane 1½ cents; time by hand 10 hours, by crane (estimated) 40 minutes. Beets—Cost by hand 9 cents, by crane 2 cents; time by hand 7 hours, by crane 30 minutes.

Plant 2. Coal—Cost (including time for switching) by hand 15 cents, by crane 5 cents; time by hand 10

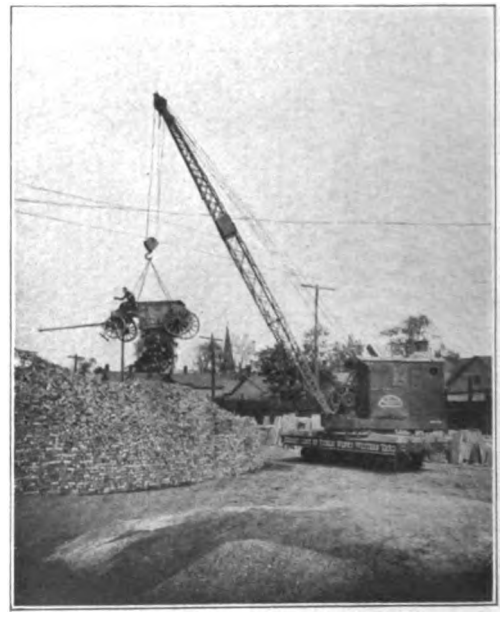

FIG. 14. A UNIQUE METHOD OF DUMPING A DUMP WAGON

20-ton Orton and Steinbrenner locomotive crane

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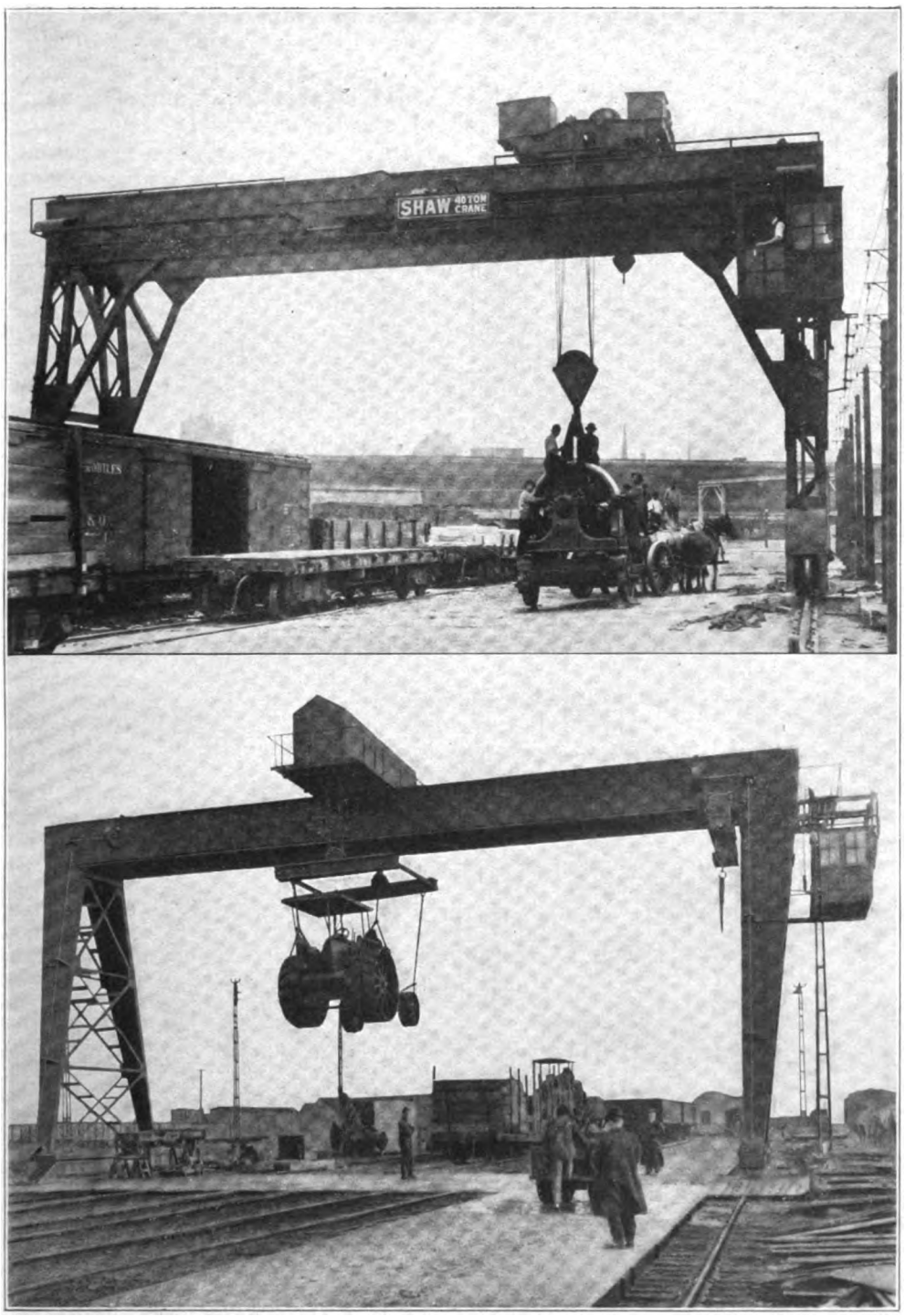

FIGS. 15 AND 16. GANTRY CRANES UNLOADING HEAVY FREIGHT

Above: Forty-ton Shaw crane in the yard of the New York, New Haven and Hartford Railroad at Providence, R. I. Below: Pawling and Harnischfeger crane loading heavy traction engines

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FIG. 17. LIFTING A COAL CAR WITH A 40-TON NORTHERN GANTRY CRANE

hours, by crane (estimated) 45 minutes. Beets—Cost by hand 10 cents, by crane 3 cents; time by hand 7 hours, by crane 35 minutes, handling 48 tons an hour.

Plant 3. Beets—Cost by hand 7 cents, by crane 2¼ cents; time by hand, 5 hours, by crane 1 hour.

Gantry Cranes

The gantry crane is of the bridge type with girders or bridge, legs, trolley, and hoists. Its functions and operations are the same as the overhead traveling crane in that it hoists loads and carries them along straight tracks, but it differs from the common overhead crane in that it does not have to have an overhead structure to carry the bridge. The bridge is carried on legs, the height of which is determined by the nature of the work the crane is to do.

Since gantry cranes have all the movements of the overhead cranes

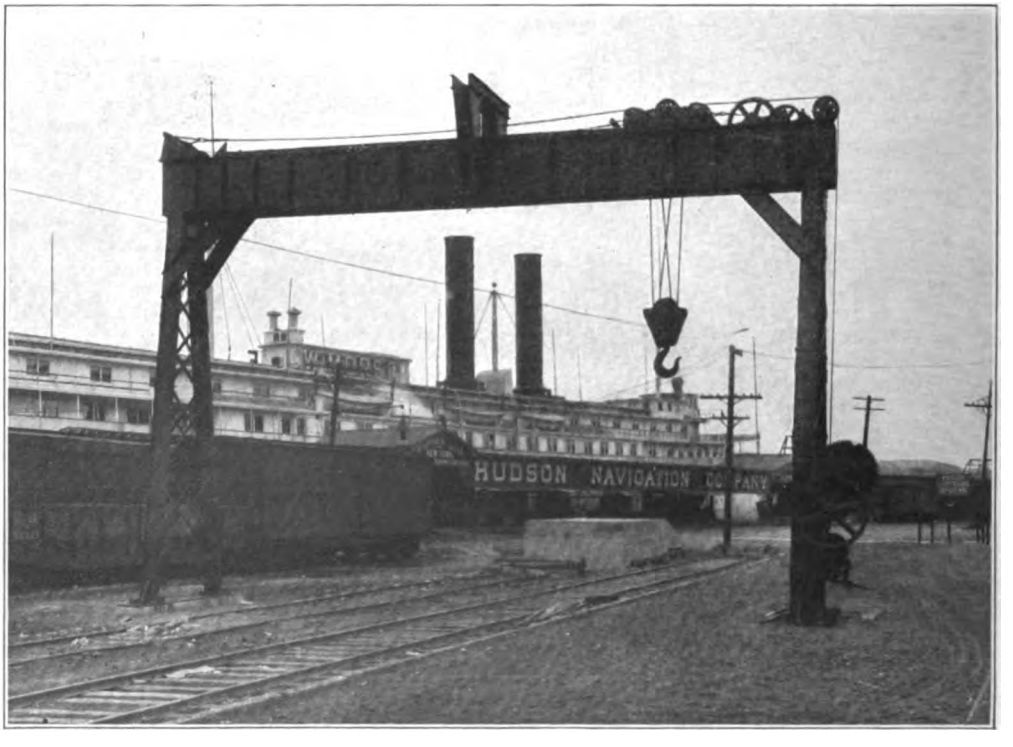

FIG. 18. UNLOADING PACKAGE FREIGHT AT STEAM-BOAT DOCKS
For this service a fixed gantry is used. The one shown is a hand-operated Industrial crane

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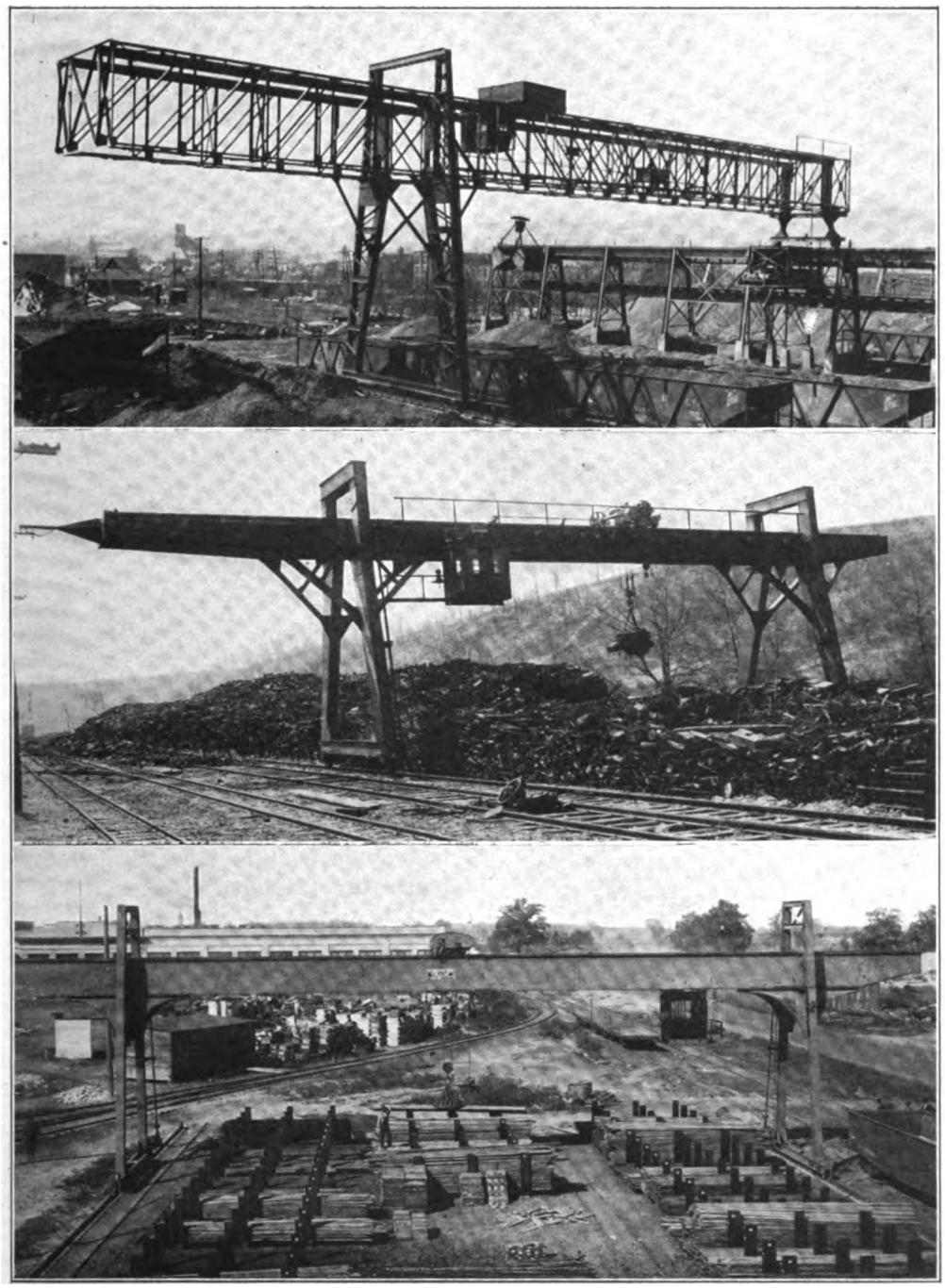

FIGS. 19, 20, AND 21. GANTRIES FOR UNLOADING BULK FREIGHT IN STORAGE YARDS

In the upper picture is shown a 4-motor Whiting gantry, span 118 feet, overhang 50 feet, equipped with a two-yard bucket for carrying coal from cars in the center to storage at the left. The middle picture shows an Alliance double-cantilever gantry equipped with a magnet for unloading scrap from cars at the left, storing it under the bridge. Below is a Northern double-cantilever magnet gantry for unloading steel bars from cars at one end, storing them in the center, and loading into wagons at the other end

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FIG. 22. BREAKING SCRAP WITH A LIFTING MAGNET

The iron ball is dropped by shutting off the current. Electric Controller and Manufacturing Company

they may utilize the same power—electricity, compressed air, or hand power. The operator is usually located on a platform or in a cab attached to the bridge. This location gives him a good view of the work at all times and aids materially in working the crane at maximum speed.

The span of the gantry crane may be anything desirable, the limit being the cost of the girder or bridge. It follows, then, that light capacity cranes may have longer spans than heavy capacity machines, viewing the question from the economy standpoint. The height of the bridge is usually great enough to allow a convenient working space over railway freight cars. In special cases the height is made greater; in fact, there are cranes made high enough to travel over shop buildings of considerable size. In cases where the work to be done warrants it there may be several gantries on one track. At the Buffalo plant of the Lackawanna Steel Company there are three gantries serving the yard and tracks between the foundry and machine shop, two of 10 tons capacity and one of 30 tons. The two 10-ton cranes had cantilevers on either end and the capacity at the ends of the cantilevers is five tons. These cranes are very high, the bridges clearing the roofs of the shops. The 30-ton crane has no cantilevers and is much lower than the smaller capacity cranes.

The radius of action of gantry cranes is much more restricted than that of locomotive cranes. The gantry must have a special track of wide gage and usually this track must be straight. The propelling of the crane is done by a motor, usually located on the bridge, which drives shafting extending along the bridge and down the legs of the crane to the trucks where the shaft is geared to the wheels through bevel gears. The usual type of gantry is a rigid structure and of such dimensions that it is impossible for it to travel around curves. Special gantry cranes have been built in which the bridge and legs form a rigid structure, but the legs were attached to the trucks by means of a sliding pivot arrangement. This type of crane is propelled by means of a cable winding on a drum. The whole arrangement allows the crane to negotiate curves and also to be slewed on a straight track until the bridge makes an angle of 15 degrees with the rails.

The application of the gantry crane to unloading material at manufacturing plants may be classified as follows:

1. Unloading heavy package freight in a limited area.

2. Unloading package freight at a fixed point.

3. Unloading bulk freight in storage yards.

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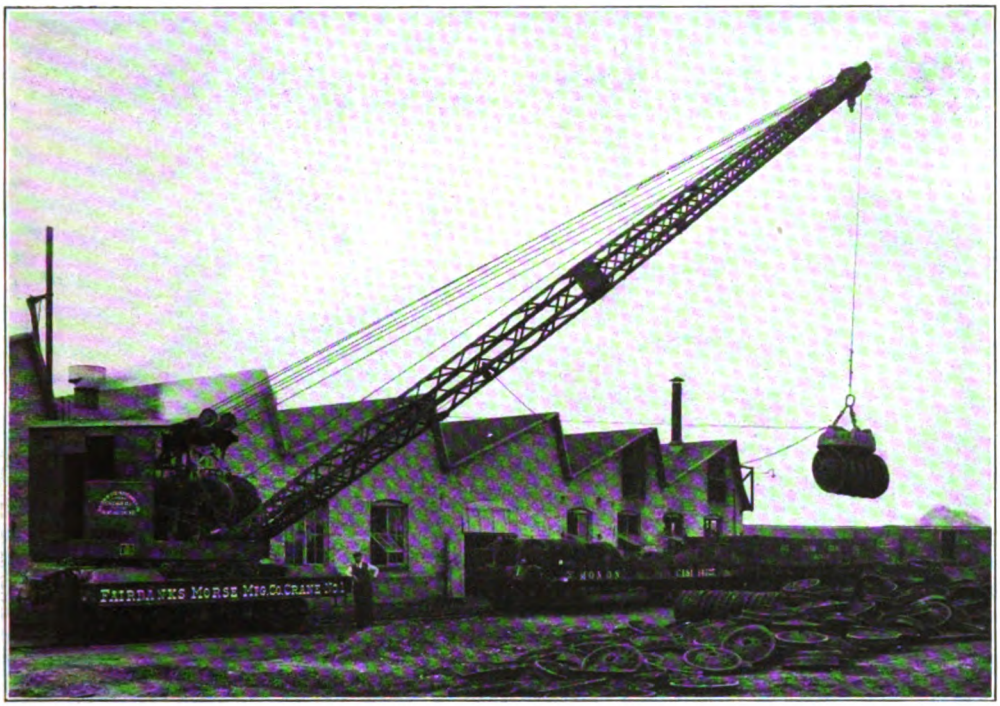

FIG. 23. LOCOMOTIVE CRANE HANDLING MAGNET TO UNLOAD CAR WHEELS
Plant of the Fairbanks Morse Co. Current for this magnet is supplied by a generating set on the crane Orton and Steinbrenner Co., Chicago

The application under the first class is well illustrated by Figures 15 and 16. The crane shown in Figure 15 is used by a railroad to unload heavy freight from cars to wagons or transfer it to other cars. This crane follows the usual practice by having two hoists, one of heavy capacity and slow speed, and one of light capacity and high speed. These two hoists are very convenient in removing heavy packages from box cars. The first operation is to enter one hook in either door and lift the package from the floor. Rollers are then placed under it and the weight is rested on these. One hook is then detached and the other used to draw the package out to a platform or truck.

The crane illustrated in Figure 16 has two independent trolleys, the heavy one running on the top of the bridge and the lighter one on the outside of the bottom flanges. The hook suspension of the heavy trolley is arranged in such a way that it does not interfere with the manipulation of the light one.

The second classification, unloading package freight at a fixed point, allows a type of crane called the fixed gantry to be used. This type is shown in Figure 18 which is a hand operated Industrial crane. Where a crane is to be used at comparatively rare intervals it would not pay to put in a power operated type as the time saved would not pay the fixed charges on the extra cost.

The third classification, unloading bulk freight in storage yards, illustrated in Figures 19, 20, and 21, is very important and the one most frequently used. Gantry cranes used for this work usually have overhanging bridges, that is, the bridge extends out over the legs on one or both

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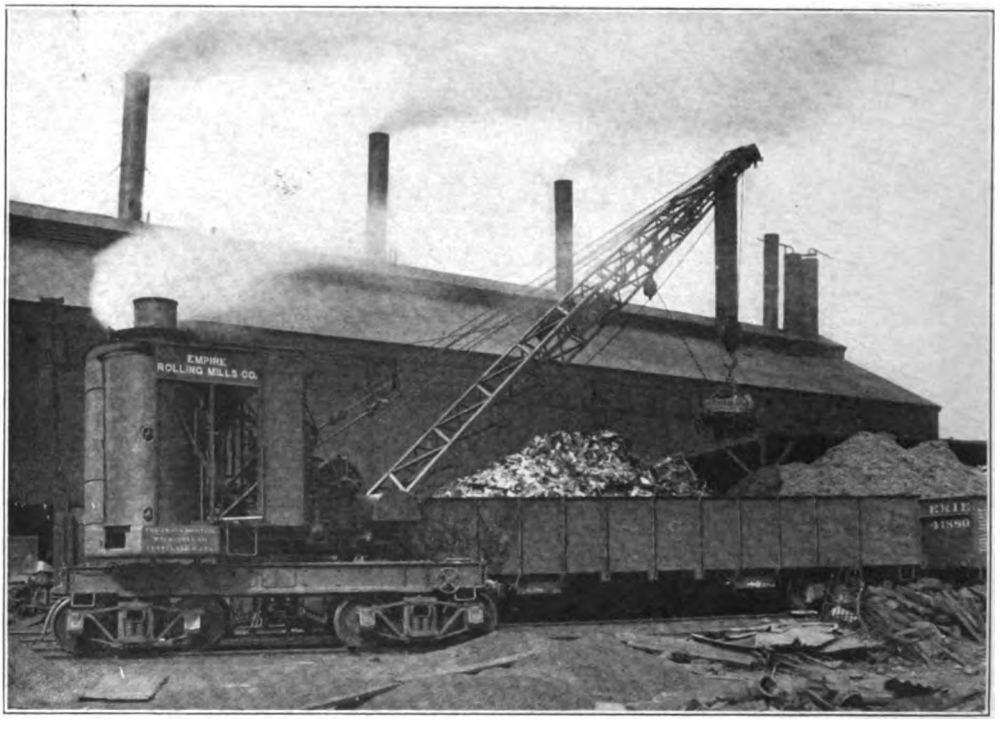

FIG. 24. UNLOADING SCRAP WITH A BROWNHOIST LOCOMOTIVE CRANE AND MAGNET
Cleveland plant of the Empire Rolling Mill Co. The same machine also handles the pig iron for this plant

ends, the overhanging portion forming a cantilever. The cars to be unloaded may be run under the center part of the bridge with the storage space under the cantilevers, or vice versa. In any case the unloading by this type of crane is very rapid, as the loads are comparatively light and high hoisting and trolley speeds are attained. If it is necessary to move the bridge with each load the process is very slow, as rapid bridge movements are not practicable. The freight cars should be placed in such position in reference to the storage pile that the bridge will not have to be moved with each load.

MAGNET CRANES

The term "magnet crane" is extensively used but it is a misnomer as any crane may be used with a magnet, the type of crane having nothing whatever to do with its usefulness in handling material in that way. Any crane equipped with a hook may use a magnet if there is a source of electrical energy convenient to use for magnetization. In many cases special generating sets are used for this purpose, particularly when the magnet is handled by a steam locomotive crane.

Magnets have been in use in handling magnetic materials for about twelve years. During that time they have become almost indispensible in the metal working trade where large amounts of iron and steel are handled by cranes.

Before the advent of the magnet the handling of steel plates, steel rails, scrap iron, pig iron, and other materials proved a tedious and difficult matter. There was delay in applying the hoisting tackle; accidents were frequent because of the slipping of hooks or appliances used to hold the material together; and with small

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pieces the cost was very high. Magnets have improved these conditions and have added an element of safety to the handling of iron and steel products. Regardless of the shape of the material the magnet attaches itself instantly to its load, holds it as long as necessary, and then releases it, all the operations being completed without having a man approach either the magnet or the load.

It must not be inferred from the above that the magnet is infallible as a means of hoisting material. It is very important that the source of the electric current be reliable, but as it is almost impossible to find a source that never fails, the magnet will sometimes drop its load. The writer witnessed one accident that has impressed this matter firmly on his mind. A magnet was handling steel billets, taking them from a railway car and putting them on the skids to be pushed into a heating furnace. A laborer stood by the skids

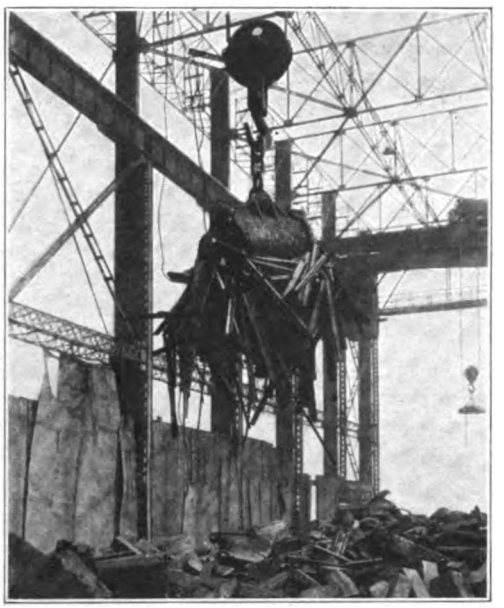

FIG. 25. HANDLING SCRAP WITH A BI-POLAR MAGNET
Electric Controller and Manufacturing Company

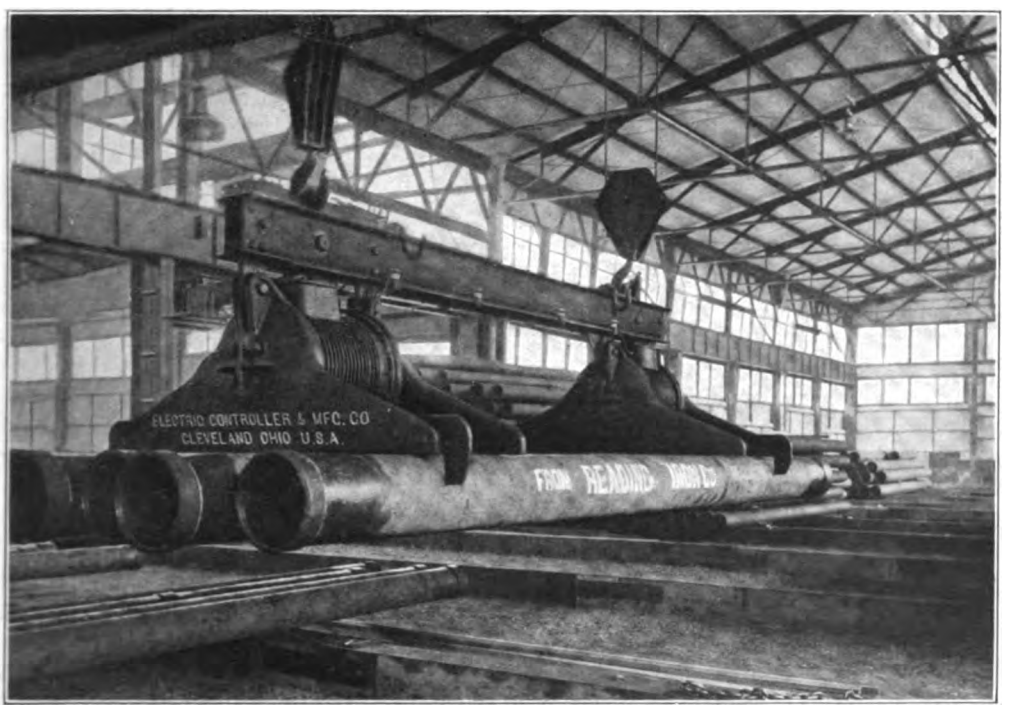

FIG. 26. LIFTING PIPE WITH MAGNETS AT THE PLANT OF THE READING IRON CO.
Electric Controller and Manufacturing Company

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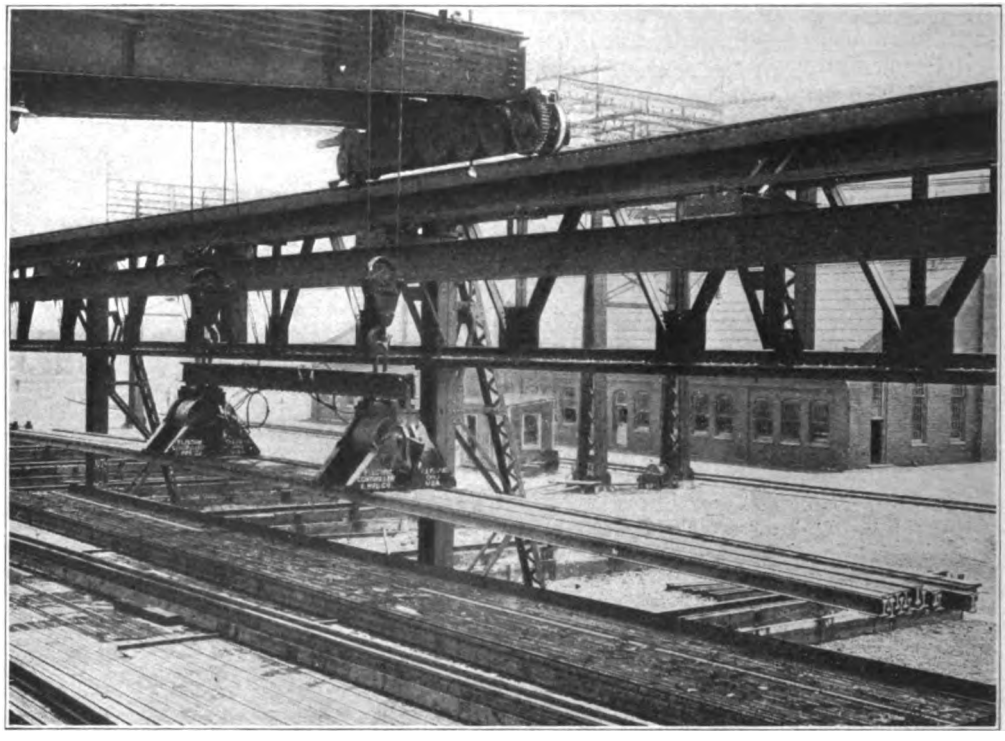

FIG. 27. A PAIR OF MAGNETS LIFTING NINETEEN 60-POUND RAILS, A TOTAL OF 30,400 POUNDS
Gary plant of the United States Steel Corporation. Electric Controller and Manufacturing Company

to assist in keeping the billets lined up in parallel rows as the magnet deposited them. The man should have used a hook which was furnished for the purpose in order that he would never have to pass under the loaded magnet. Familiarity breeds contempt and always will, so the laborer discarded the hook and worked in such a way that the loaded magnet passed over his head. But one day something went wrong in the power house at Niagara Falls, twenty-five miles away, and a switch was pulled as the laborer stood under the billet-loaded magnet!

The ordinary magnet used for general work is in the form of a thick disc which is held by the crane hook with a three-point suspension in such a way that the bottom or lifting face of the magnet is horizontal, as shown in Figure 22 which illustrates one use of the magnet, lifting a large steel ball and dropping it in order to break up scrap. Before the magnet was used for this purpose the ball was cast with an eye in which a special trigger hook engaged. To release the ball the trigger was pulled by a lanyard, an outfit that did not always work well. With the arrangement shown it is only necessary to bring the energized magnet in contact with the ball to "hook on," and when the ball is up at the proper height it is dropped just as easily by simply shutting off the current to the magnet.

Another use of the magnet is shown in Figure 23, where car wheels are being handled by a magnet on a locomotive crane. Without a magnet these wheels would be awkward to handle as they naturally collect like rolls of coin making it difficult to get

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a chain or rope through the holes. With a magnet the matter is very simple.

In this particular case the electric power for the magnet is generated on the crane by means of a high-speed engine direct-connected to a generator. The engine is a single-cylinder vertical unit with a cylinder 6 inches diameter and a stroke of 5 inches. The generator has a capacity of 7½ kilowatts at 220 volts although the magnet, which is 43 inches in diameter, takes about six kilowatts when warm.

The application of the magnet in handling steel or iron scrap is clearly shown in Figures 24 and 25. The former is a standard disc-shaped magnet but the latter is of the bi-polar type better adapted to handling coarse scrap. Probably there is no other field of work in which the magnet has shown such a saving as this. Formerly when scrap was handled by cranes it was necessary to fill buckets or boxes with fine scrap by hand or bundle coarse scrap in the same way before the crane could lift it. Now all hand work is dispensed with.

Figures 26 and 27 show the application of bi-polar magnets for handling such long materials as pipe and rails. Both the magnets shown in these two illustrations are of the same type, the only difference being that the ones handling pipe have toe pieces bolted to the magnet tips to prevent the pipe from rolling off the ends of the magnets. It is a curious fact that while the magnetism will prevent the pipes or any such round materials from dropping it will not prevent them from rolling.

The foundry furnishes a rich field for the application of the magnet for handling flasks, copes, and castings, and for cleaning the sand from nails and other small pieces of iron or steel. Mr. H. F. Stratton in the *Iron Trade Review* of November 20, 1913, tells of one foundry where the magnet is used to do many operations that result in saving money. After the castings have been poured they are shaken out by two men who first lift off the cast steel cope flasks. These are then stacked on edge, side by side, between rows of molds. The crane then comes along with a magnet, picks up these cope flasks, generally getting four or five at a time, and stacks them in a pile at one side of the molding floor.

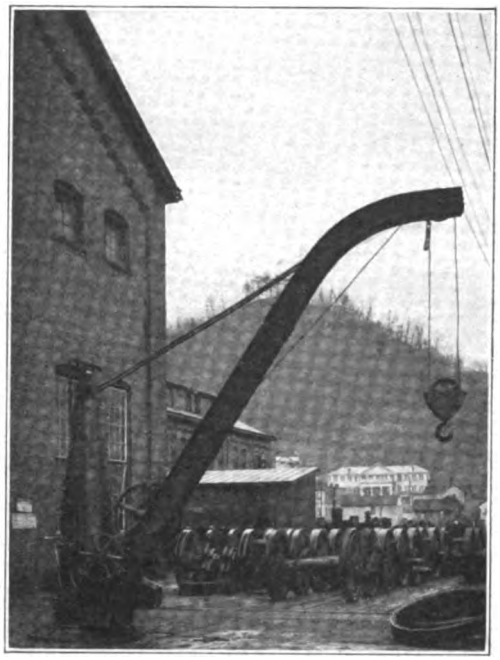

FIG. 28. PILLAR CRANE OPERATED EITHER BY HAND OR BY COMPRESSED AIR
Northern Engineering Works, Detroit

The castings, which in this particular foundry are not very large, are then dragged from the sand by means of a hook and are tipped into piles which include several castings. These piles are picked up by the magnet, carried to the end of the building and dumped at a point where the castings are rough cleaned and the risers broken off. The drag flasks are then

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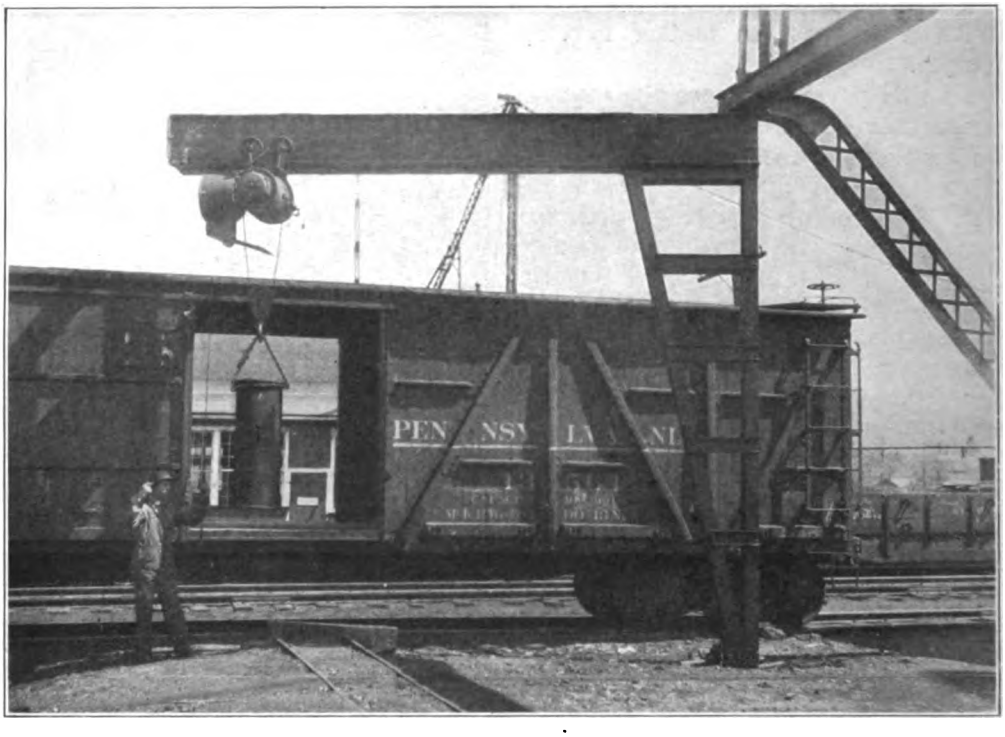

FIG. 29. HAND-OPERATED JIB CRANE WITH AN ELECTRIC HOIST ON THE BOOM
Shepard Electric Crane and Hoist Co., Montour Falls, N. Y.

picked up by the crane and handled in the same way as the cope flasks.

For the next operation the magnet is lowered to within a few inches of the sand and slowly moved along horizontally, gathering up all the small pieces of iron that have been left in the sand. This use of the magnet is so effective in its cleaning that the sand is seldom screened to remove the iron, nails, etc.

This magnet is also used for handling such equipment as steel boxes or buckets which are used for conveying sand from one point to another, as the crane operator can make better time by handling these with a magnet than he could if he had to wait for a man to fasten the crane hook on the article to be moved. This crane also fills the charging boxes for the open-hearth furnaces in this foundry.

In order to give some idea of their size and lifting power some sizes of magnets manufactured by the Electric Controller and Manufacturing Company are given here. The type shown in Figure 22 is made in four sizes, 36, 43, 52, and 61 inches in diameter. The weights of these vary from 2100 to 6600 pounds and the current consumption from 11 to 47 amperes at 220 volts. The weights which the magnets will lift depend on the material to be handled. The smallest magnet, the 36-inch, will lift 20,000 pounds in the shape of billets or slabs, but only 200 pounds of loose tin or lamination scrap. These figures represent the two extremes. The quantity of scrap lifted varies from 200 to 900 pounds. The 61-inch magnet will lift 50,000 pounds of billets or slabs and from 900 to 3000 pounds of scrap.

The cost of handling material with

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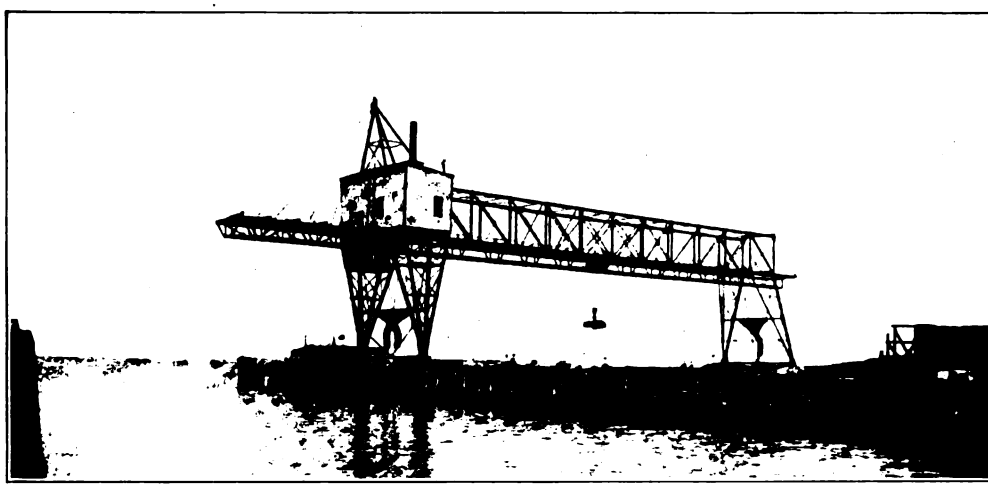

FIG. 30. BRIDGE FOR UNLOADING BULK MATERIAL AT PORT TAMPA, FLA.
Operated by means of steam hoisting engine and handling a 2-ton clam-shell bucket. C. W. Hunt Company

magnets depends on so many factors that it is impossible to give figures covering general cases. In the handling of scrap a great saving may be effected, as shown by figures appearing in the *Railway Age Gazette* for July 16, 1915. The cost of this work on the Buffalo, Rochester and Pittsburgh Railroad was as follows:

Kind of scrap	Crane cost	Hand cost
No. 1 wrought iron.....	$0.04	$0.22
Busheling, No. 2 wrought iron and malleable....	0.02	0.10
Cast iron and mixed steel	0.02	0.09
Sheet steel	0.20	0.30

In general it might be said that the magnet saves about 90 per cent of the labor cost over the method of handling scrap by hand.

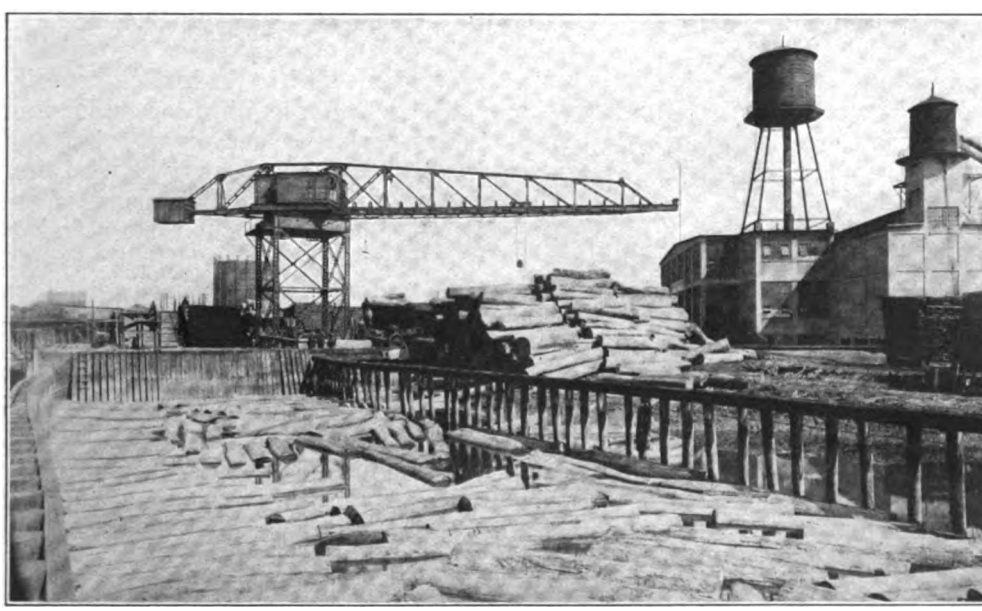

FIG. 31. HANDLING LOGS WITH A 10-TON REVOLVING CANTILEVER-BRIDGE CRANE
Erected by the McMyler-Interstate Company at the plant of the Mengel Box Co., Jersey City. The crane is operated by an electric hoist built by the Lidgerwood Manufacturing Co. of New York

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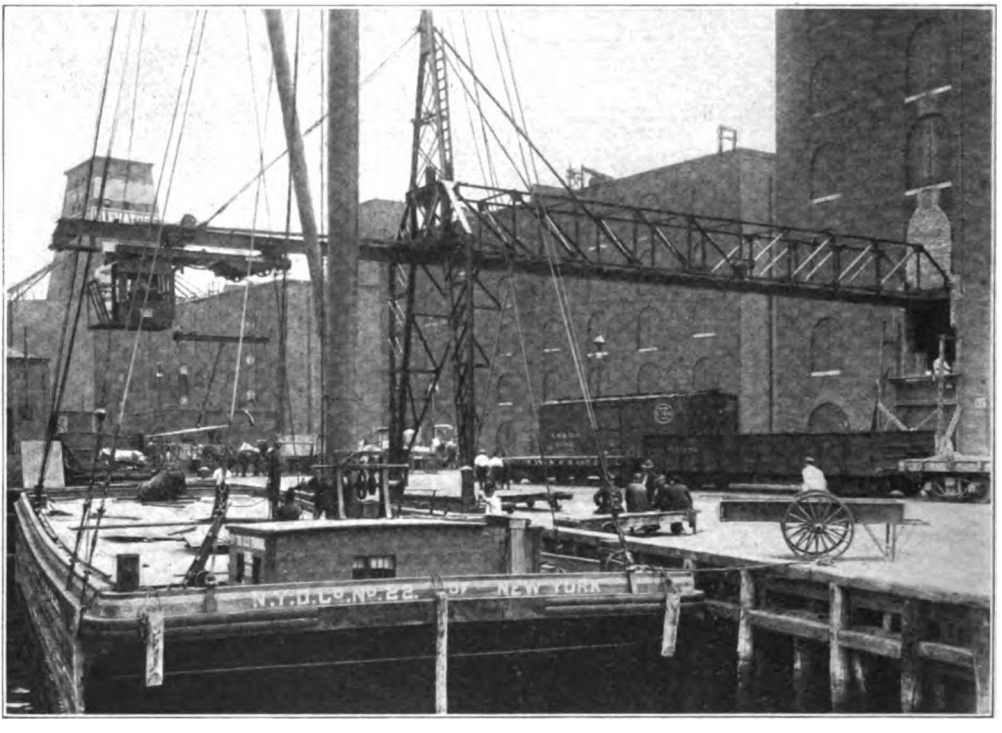

FIG. 32. DOCK END OF A MONORAIL SYSTEM BUILT FOR THE NEW YORK DOCK COMPANY

Freight is taken from the boat by an electric hoist and carried either to the warehouse, to the cars, or through the warehouse to cars and wagons in the next street. Built by the Brown Hoisting Machinery Co., Cleveland, Ohio

There are other important items which enter into the question of the desirability of using magnets aside from the actual cost. There is the question of speed. In many cases a saving will be effected if the work is done quickly. This is particularly true in unloading cars. In one instance a magnet on a locomotive crane unloaded 41 tons of old boiler grates in 40 minutes, 56 tons of track spikes in 33 minutes, and 44 tons of miscellaneous scrap in 35 minutes. At one scrap yard on the Pennsylvania Railroad a locomotive crane with a magnet handles 400 tons of scrap a day.

With a magnet, material can be economically piled to a height which would be out of the question where hand labor is employed; hence, where only a restricted area is available for the storage of materials, the value of this area may be largely increased.

Special Types of Cranes

There are many cases in which a crane is needed to do just one special job, such as loading or unloading heavy packages at a given point, and in such cases cranes may be used that are very limited in their scope of action. A machine shop may find it necessary to take its finished product out of the building on industrial cars or trucks in order to load it on railway cars. If this product can all be loaded at one point then an inexpensive type of crane may be used, the cost of the crane depending on the loads to be handled and the method of operating. If a crane is to be used infrequently it may be operated by hand, as a crane must be operated frequently in order to pay the fixed charges on the additional capital invested in the operating mechanism. On the same premise we might logic-

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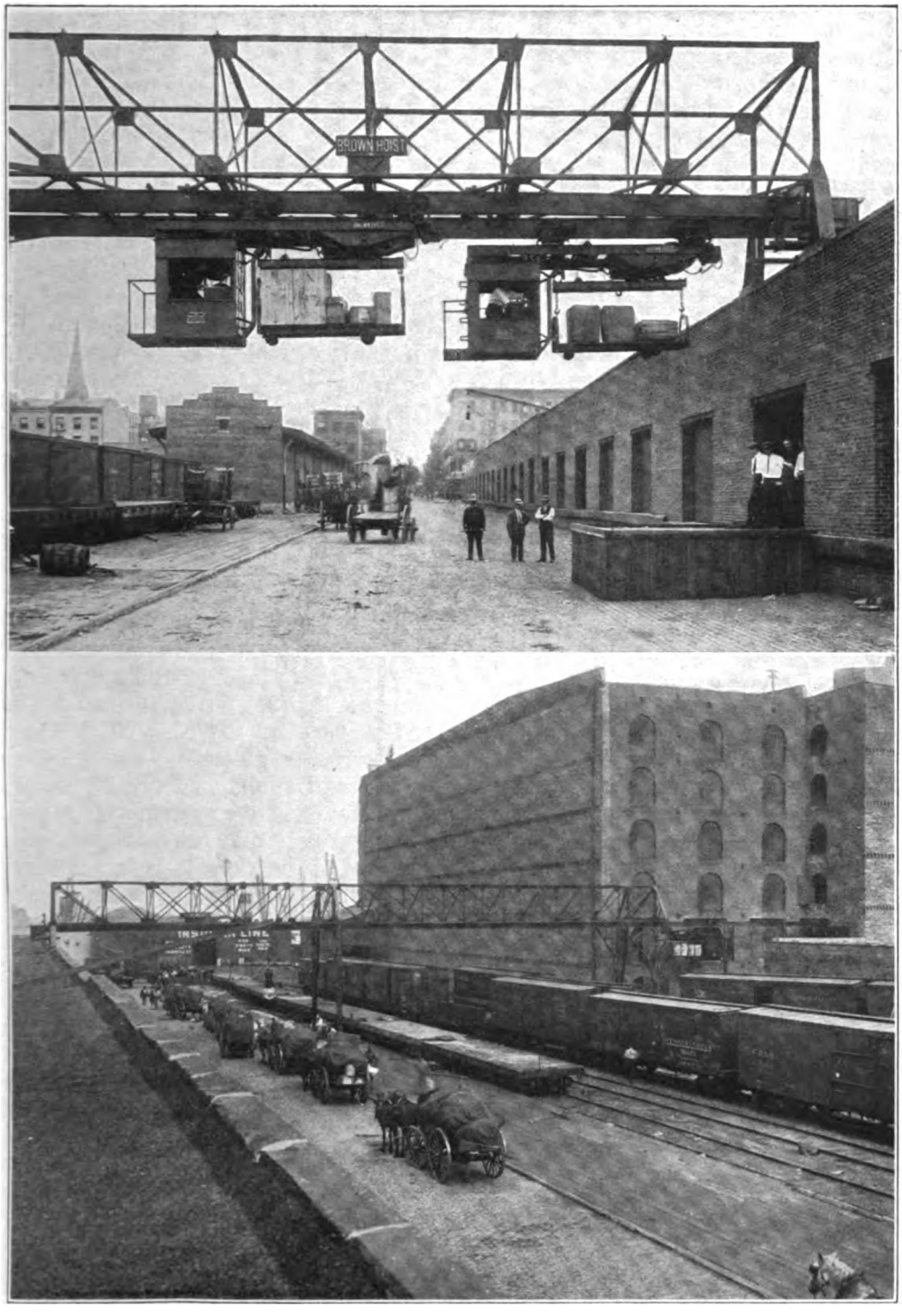

FIGS. 33 AND 34. LOADING CARS AND WAGONS AT THE FREIGHT-HOUSE END OF THE NEW YORK DOCK COMPANY'S OVERHEAD MONORAIL

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ally conclude that under certain conditions a crane should not be used at all but the work done by hand.

Figures 28 and 29 illustrate two cranes that are frequently used for loading and unloading at a given point. The pillar crane in Figure 28 loads from the ground to industrial cars running into the shop at the left or to railway cars on a track not visible in the picture. Naturally, then, it can load from one car to the other, the manner in which it does most of its work. These cranes are built in various sizes up to about 15 tons capacity and are operated by electricity, compressed air, or hand. The particular one shown has a combination arrangement by which it can be operated either by hand or by a compressed air motor. The crane illustrated in Figure 29 is of the jib type and carries an electric hoist on its I-beam boom. A crane thus equipped covers a greater area than the pillar crane but its capacity is less. This particular crane transfers material from railway cars to industrial cars and vice versa. The electric hoist enables it to work very rapidly.

When manufacturing plants receive bulk material by water, a rapid unloading plant of fairly large capacity may be used to a good advantage. Machinery of this type has already been described by the author in this magazine in the series of articles on The Machinery of the Steel Industry which was published from June to September, 1911. Locomotive cranes are admirably suited to this kind of work as are the bridge types, either gantry or cantilever. A gantry type is illustrated in Figure 30. This crane may unload bulk or package freight from vessels directly into cars which run under the bridge, or deposit it in storage. The outgoing freight may be handled the same way.

The revolving cantilever crane shown in Figure 31 is located at the plant of the Mengel Box Company, Jersey City, N. J. It handles African cedar logs of large diameter and twelve feet in length in loads up to six and one-half tons, taking them from barges or directly from the water, and piling them in storage. The boom or bridge is 85 feet long and 40 feet above the water. The operating machinery consists of a double-drum electric hoist, the 75-horsepower motor using two-phase 60-cycle, 220-volt current. In handling the logs only one drum of the hoist is used, but the crane also unloads coal for the power plant with a clam-shell bucket for which work both drums are used.

While it is not the purpose of this paper to go into the details and applications of the monorail, that being reserved for a later part of this series, we will show one application of this system to loading and unloading. Figures 32, 33, and 34 illustrate the system used by the New York Dock Company for unloading and loading barges and ships. Figure 32 shows the dock end of the system with a cantilever which may be lowered over the boat. The freight is taken from the boat by the electric hoist on the monorail car and may be loaded upon railway cars or trucks on the dock. If the freight is to go into storage, it is taken by the monorail into the warehouse at the right. Beyond the warehouse is the freight house and the monorail is extended to that over a street and other railway tracks. Figures 33 and 34 show the extension beyond the warehouse. It will be noticed that the hoist in Figure 32 is picking up steel plate by means of hooks, while the other two illustrations show the hoist with loaded warehouse trucks. The only addition required to change from one load to the other is the cable sling.

To be continued.

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WROUGHT-IRON OR STEEL PIPES?

By L. C. Wilson

In a series extending from the January to the May issues of this magazine, Mr. Wilson covered the general problems of rust prevention. He has supplemented that series with two concluding chapters; the first, which appeared last month, dealt with the influence different metallic elements exert upon the prevention of corrosion; and the second, in the following pages, takes up the controversy of the relative merits of wrought-iron and steel pipes. All of the material has been extensively revised by Mr. Wilson, and, together with other data, will appear shortly in book form.—THE EDITORS.

IT has been shown in the previous article that iron and steel may be made less susceptible to corrosion by the addition of certain elements, but it is a matter of common experience that some parts are more resistant to such attack than others without these additions, and brief mention has already been made of the fact that the iron manufactured today is not quite the same, in some respects, as that produced formerly. The substitution of modern methods and machine processes for the old, hand way of refining these materials has resulted in a different product both chemically and physically, and co-incident with these changes in method and product there has been a tremendous increase in the use of iron and steel and perhaps an equally great alteration of the conditions of service. It is not strange, therefore, that a good deal of difference of opinion, doubtless honest enough at bottom, has arisen regarding the relative merits of the old and new varieties, especially their resistance to corrosion. The controversy over wrought-iron and steel pipe, for instance, has been very animated.

Perhaps one reason for this is that nearly everyone uses pipe, or comes in contact with it in some way; then the conditions to which a steam or water pipe are exposed are rather unusual and just the opposite of what generally obtains. On the whole, ordinary ironwork is subjected to a large excess of air containing varying amounts of moisture and gases; only at long intervals, as from rain and snow, does the surface become wet. The inside of a pipe line, on the other hand, is in contact with a large excess of water which may contain much or little oxygen or air. In a line where the water is frequently drained out of the pipes or where it holds a large amount of air it will be seen that the conditions for rapid and severe corrosion are present, and it is not surprising that a line or a section of it may go to pieces in a comparatively short time. When such a case happens it is very easy, and perhaps natural, to ascribe it to inferior materials or something of that sort, and unless trouble is taken to ascertain all of the facts in the case very erroneous notions may, and often do, become current. Such a one is the belief held by some that steel pipe is considerably inferior in point of corrodibility to pipe made from wrought iron.

There is perhaps no doubt that the steel produced ten or fifteen years ago was not the equal in all respects to that turned out today; but by reason of the improvements which are being introduced from time to time the quality has risen until it may safely be said that there is no ground

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for comparing it unfavorably with wrought iron, at least without a fair trial.

It may be remarked that this subject is by no means a new one and there is available a good deal of literature concerning it, but it is considered to be worth while to review some of this briefly and, without in the least desiring controversy with any whose opinions or interests lead them to disagree with the conclusions stated herein, to present the results of various investigations in the hope that this may help to clear up any false impressions. Much money is lost every year through ignorance and prejudice, and at least some of this occurs in buying ferrous metals, since certain varieties of these are claimed to be superior to others and a higher price is charged for them. If the facts show that this extra premium is warranted, well and good; if not, it is a sheer waste of money.

Before considering the data bearing on this point, however, it may be well to take up briefly the processes employed in the manufacture of these two materials, so that a more definite idea of what each is may be obtained.

The way in which iron ore is reduced in the blast furnace, with the production of pig iron containing several per cent of other metals and metalloids, has been previously described. As noted, the method does not permit of rolling or similar treatment, therefore, the iron must be refined before it is suitable for use other than in making castings. Iron may be refined in several ways, but for our purpose only the puddling furnace and Bessemer converter need be considered, as the terms wrought iron and steel, as used in the manufacture of pipe, refer to the product of these.

In puddling, the iron is melted on a bed of iron ore which gives up part of its oxygen to oxidize the carbon, silicon, and manganese, and, to a less extent, the sulphur and phosphorus. The greater the purity of iron, the higher the temperature at which it melts; therefore, the metal in the furnace becomes pasty after a time as the impurities are burned out, and is worked into a ball and removed.

This ball is rolled into bars of convenient size which are cut and piled up, then reheated to a welding temperature and rolled again into a bar of the desired dimensions.

Wrought iron produced in this manner is a very pure article, the greatest and most objectionable part of the impurities being the slag, which is scattered all through the metal and gives it the apparently fibrous structure so characteristic of its appearance after rolling. These fine slag lines are easily detected and form a ready means of distinguishing between wrought iron and that produced by other methods. It is only necessary to smooth down a small spot with a file when the lines will show up; best, under a magnifying glass.

It can be seen that the puddling process is rather slow and expensive, since only a limited amount of metal, a few hundred pounds at most, can be treated at a time. Something like an hour and a half is required for a charge, and considerable skill and care are needed in order to obtain a good product. The presence of two per cent or so of slag distributed irregularly throughout the mass can hardly tend to increase the homogeneity, and it is generally accepted that lack of this is of more importance, from the standpoint of corrosion, than the presence of a reasonable amount of impurities thoroughly and uniformly mixed in. It is very hard to weld perfectly sheets or bars several inches in width, so laminations are met with and may give trouble.

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In the Bessemer process, the molten iron from the blast furnace is run into huge mixers, then into big egg-shaped converters, where cold air is blown through the charge by means of tubes at the bottom. The entering oxygen rapidly burns out the impurities, and thereby generates a large amount of heat; so no difficulty is experienced in keeping the metal melted. The length of time the air is blown through is determined by the color of the flame issuing from the mouth of the converter. As might be expected, more or less of the iron is oxidized at the same time; but the addition of a small amount of manganese, for example, will take care of these oxides, so the requisite quantity of this, calculated from an analysis of the iron, is added together with such other elements as may be needed.

It requires only ten or fifteen minutes to convert as many tons of iron into an equal quantity of steel, so in point of speed and general economy the Bessemer process is superior to the other. It is especially adapted to making low carbon steel, and, as a matter of fact, gives a product which is more nearly pure, considered on the score of total impurities, than that from the puddling furnace. As a general proposition, the silicon, carbon, sulphur, manganese, and phosphorus may be lower in the wrought iron than in steel, but the former will contain about two per cent of oxides, while in steel these will not run over one or two tenths of one per cent. From the nature of the process whatever impurities are present are well distributed, and as the metal is rolled directly into skelp, without cutting and re-welding as in the case of wrought iron, the danger from laminations is greatly reduced.

Up to about 28 years ago hand puddled iron was used entirely for making pipe; for various reasons steel had not been successfully welded, and as the quantities needed were comparatively small there was no trouble in supplying the demand. With an increasing use of pipe, however, the discovery that steel could be welded when treated properly, and the discovery of cheaper and better processes of making this material, caused it to be employed more and more, and two classes of pipe appeared on the market, iron and steel. With many manufacturers in the field different grades of these appeared, and now there are a number of such grades; in fact there is as much difference between some of the wrought irons as there is between it and the steels, and there is a corresponding disparity between the latter. All of this has tended to increase the confusion, and inasmuch as any new material is liable to be looked upon with suspicion, it is perhaps only natural that there should have arisen much lack of agreement regarding the length of life which iron pipe, as contrasted with that made from steel, might be expected to give.

As a consequence, a good deal of experimental work has been done, and several investigations of the condiions found in actual service have been carried out to find the answer to some of these questions.

An experiment conducted somewhat over twelve years ago by the Bureau of Steam Engineering of the Navy Department on lap-welded Bessemer steel, lap-welded iron, seamless cold-drawn steel, and seamless hot-drawn steel boiler tubes, may be of interest.

Care was taken to secure good, representative samples of these materials, and analysis showed them to be of the following average composition:—

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	Cold-drawn seamless	Hot-drawn seamless	Bessemer steel	Iron
Silicon	0.005	0.005	0.008	0.024
Sulphur	0.043	0.039	0.081	0.014
Phosphorus	0.015	0.016	0.110	0.038
Manganese	0.50	0.49	0.31	Trace
Carbon	0.16	0.14	0.063	Trace
Oxide	0.23	0.30	0.28	1.03

Without going too much into detail, the test consisted in weighing the parts, then immersing them in distilled water, through which air was bubbled, for a total of sixty-four weeks divided into four periods of sixteen weeks each. At the end of each period the samples were removed, thoroughly cleaned, and weighed. The results may be averaged thus:—

AVERAGE LOSS IN GRAMS PER SQUARE INCH

	First Period	Second Period	Third Period	Fourth Period	Total Loss	Loss Compared with Iron as 100
Hot-drawn Open-Hearth Steel	.3034	.5333	.3510	.5070	1.6947	93.7
Bessemer Steel	.3147	.4950	.4043	.4945	1.7085	94.5
Cold-drawn Open-Hearth Steel	.3232	.5564	.4502	.5017	1.8315	101.3
Charcoal Iron	.3326	.5896	.3966	.4893	1.8081	100.

It will be seen that there was no great difference in the behavior of these four classes of materials as far as loss in weight is concerned; the charcoal iron samples, which showed the greatest initial loss, ended up with a decrease about 6.3 per cent larger tnan that of the open-hearth, hot-drawn tubes, which suffered the least.

From data collected by the American Society for Testing Materials, 1908, and experiments reported in *The Iron Age*, the table on the following page has been drawn up summarizing the results of a number of other laboratory tests, largely on wrought iron and steel skelp. The specimens were exposed to the weather or immersed in different kinds of water and the loss in weight determined at the end of the experiment.

These results show that even the steel manufactured fifteen years ago was slightly better than the wrought and charcoal irons of the same period.

But while laboratory tests are useful in giving indications of what may be expected in practice, the results obtained in actual service are naturally more reliable; so about the time the last of the above tests were being carried out, a new line of investigation in the shape of trial installations was started.

Prof. Thomson joined up a hot water line of wrought iron and steel pipe in alternate sections, so that they would all be subjected to the same conditions. After a year of service, he concluded that steel might be expected to stand up about 7.5 per cent longer, under such conditions, than wrought iron.

A short time later a test carried out under similar circumstances under the auspices of the American Society of Heating and Ventilating Engineers, using steel and iron pipes supplied by several makers, checked up closely enough with the previous one and the report of the trial concludes: "We believe (this test) demonstrates that modern steel pipe of good quality is at least as durable as modern strictly wrought-iron pipe of good quality, and is very much superior to a poor quality of wrought iron in this class of work."

Various other tests carried out by different observers under a variety of conditions have lead to the same general conclusion. Thus, several experiments conducted by the Pittsburg Coal Co. and the H. C. Frick Coke Co., to mention only two, wherein the sam-

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INVESTIGATIONS ON THE CORROSION OF WROUGHT IRON AND STEEL

Authority	Date	Conditions of test	Duration of test	Material tested	Relative loss of weight
Prof. H. M. Howe	1897	Sea water norm. temp.	2 years	Steel skelp	117 per cent
				W. I. skelp	100 " "
Prof. H. M. Howe	1897	River water norm. temp.	2 years	Steel skelp	94 " "
				W. I. skelp	100 " "
Prof. H. M. Howe	1897	Weather	2 years	Steel skelp	103 " "
				W. I. skelp	100 " "
U. S. Navy Dep't	1901	Aerated, dist. water norm. temp.	64 wks	Charcoal iron	100 " "
				Pipe steel	94.5 " "
National Tube Co.	1904	Aerated brine norm. temp.	6 mos.	Puddled iron	100 " "
				Pipe steel	106 " "
National Tube Co.	1905	Aerated water 180° F.	3 mos.	Puddled iron	100 " "
				Pipe steel	90.6 " "
National Tube Co.	1906	Aerated brine 180° F.	3 mos.	Charcoal iron	80 " "
				Puddled iron	100 " "
				Pipe steel	75.3 " "
Prof. H. M. Howe	1906	Aerated sea water 180° F.	3 mos.	Charcoal iron	94.4 " "
				Puddled iron	100 " "
				Pipe steel	94.2 " "

ples were immersed in running mine water, which generally contains considerable quantities of acid, show that steel corrodes at no greater rate than wrought iron. Again, the work of Howe and Stoughton gave results in broad agreement with this conclusion. Commenting on the tests of these two experimenters and the evidence which they have collected, Alfred Sang says, in his book: "Of ten different tests made by different observers in different places, seven resulted decisively in favor of steel; in the other three cases the results were very slightly in favor of the iron, but in only one of the latter was the material of modern manufacture.

"The tests which resulted in favor of steel were as follows, all except the two first being carried to destruction: Seven months in hot, aerated salt water; sixteen months buried in dampened ashes; exposed to sulphuric acid coal-mine water; in railroad interlocking and signal service; in locomotive boiler service.

"It was also found that steel tubes made in 1906 pitted much less than those of 1897 from the same makers, indicating the superiority of modern steel over that of some years back in this particular respect."

All of the work on this subject has not been confined, however, to either laboratory or short installation tests and at least two rather extended investigations have been undertaken on pipe lines as they are found in service. The first was conducted by Prof. Woolson on some of the public bath houses of New York City, where much trouble was being encountered from the rapid corrosion and consequent leaking of the hot-water pipes.

A thorough examination of the situation showed that conditions in these bath houses were not materially different from those found in similar installations in other places. Croton

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water was used, being heated in various standard types of heaters to a temperature of 160° F. to 200° F. The quantity of water passing could not be determined, but it was considerable, as many thousands of baths were, and are, given in some of these places during the hot weather. It developed, further, that all of the pipe which had been in use four years or over had begun to give trouble, and in a few places pipe only two or three years old had perforated.

In all, eleven houses were inspected, but for various reasons samples could be collected from only eight. From these eighty-nine specimens, perforated and worthless, were obtained for examination. They varied in size from three-quarters to four inches in diameter, the majority being one and one-half to two inches. Small pieces were sawed from each of the specimens, crushed, and the fracture carefully examined by two experts independently to determine whether the material was wrought iron or steel; chemical analyses were then made of all samples which were at all doubtful in classification. The results of these tests were checked to avoid all possibility of error.

As a matter of interest, in showing the difference between the two kinds of metal, the following are typical results of the chemical analyses:

ANALYSES OF PIPE FROM NEW YORK CITY BATH HOUSES

Per cent Manganese	Per cent Carbon	Per cent Oxide	Classified
0.48	0.09	0.20	Steel
0.32	0.08	0.26	"
0.42	0.08	0.21	"
0.38	0.08	0.30	"
0.50	0.08	0.38	"
Trace	Trace	2.85	Wrought iron
"	"	2.40	"
"	"	2.20	"
"	"	2.50	"
"	"	1.75	"

From all of this work it was decided that seventeen out of the eighty-nine samples were wrought iron; these had come from six of the eight houses. Of the other two, no samples were examined from one and those collected from the last were proved to be steel. The above data may be arranged in tabular form as follows:

BATH HOUSES AND SAMPLES OBTAINED FROM EACH

Material supplied	Bath house	Classification
Probably steel	11th St.	2 Iron—6 Steel
" "	76th "	2 " —5 "
Not certain	23rd "	2 " —4 "
Steel	41st "	5 " —7 "
"	Rivington "	2 " —23 "
"	109th "	4 " —11 "
		17 — 56
Total of mixed samples		73
Steel	Allen St.	16 steel
Total of all samples		89

The contract specifications for all except two of these houses called for wrought-iron pipe, galvanized, but plumbers and dealers often do not make any close distinction between iron and steel pipe, so the latter may be supplied alone or mixed with the other. A few years ago many mills were making both kinds of pipe and it would be very easy to mix them in shipment.

However that may be, it will be seen that of the mixed samples 23 per cent were wrought iron. Bearing in mind that the two kinds of pipe were used indiscriminately and, therefore, were all exposed to the same conditions, that all samples were tested to destruction, and that probably not more than ten per cent of the welded pipe on the market is wrought iron, it appears that steel showed up to very fair advantage.

After his investigations Prof. Woolson decided: "In my judgment, from the evidence collected, there was absolutely no difference in the corrosion of the two classes of pipe. They appeared to be equally susceptible to the attack."

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A similar study was made by Dr. Walker in an attempt to determine how these materials stood up in service when both were used in the same system, separated from each other only by a coupling. Under these circumstances, the wrought-iron and steel pipe would be subjected to as nearly identical conditions as could be obtained, so a fair basis of comparison should be afforded.

Briefly, the method pursued was to examine a large number of steam and hot-water systems operating in different places and under different conditions, and to collect samples of wrought-iron and steel pipe. It chanced that the majority of the samples collected came from hot and cold water feed systems, but enough were obtained from live and exhaust steam lines and other installations to make the results of general interest.

The specimens were split lengthwise and carefully cleaned of rust and accumulated scale by the use of ammonium citrate solution which does not attack iron, after which the extent of corrosion was calculated by measuring with a micrometer the ten deepest pits occurring in a length of about twelve inches.

In all, it was possible to obtain sixty-four comparisons and the results may be summed up thus:

COMPARATIVE CORROSION OF WROUGHT-IRON AND STEEL PIPE

Instances where iron corroded more than steel	20
Instances where steel corroded more than iron	18
Instances where iron and steel corroded equally	9
Instances where corrosion was negligible	17

In the light of the facts brought out by this work, Dr. Walker felt justified in concluding that on the average there is no difference in the corrosion of iron and steel pipe.

Immersion in sulphuric acid of a certain strength has been used as a means of determining the comparative resistance to corrosion of different samples of iron and steel, and as an interesting sidelight to the above work, Dr. Walker conducted some experiments to find out whether this test has any real value. As he reports it: "In order to show what relation may exist between the so-called acid corrosion test and the real corrosion as found in service, eleven pairs of iron and steel were selected and subjected to 20 per cent sulphuric acid for four hours at room temperature. Four pairs were selected in which the steel was decidedly better than the iron in service, four in which the iron had shown decidedly better than the steel, and three in which there was no difference between the two metals.

"In six instances the relative corrosion as shown by the sulphuric acid test corresponded with the corrosion as found in service. In five instances corrosion as shown by the acid test was exactly contrary to that found in service. Although the greatest care was taken to have the specimen of the same size, cleaned in the same way, and in the same physical condition, the results show that no reliance can be placed in this accelerated acid test, but that it may be entirely erroneous and very misleading. Not only did the acid test not agree with the service test when steel was compared with iron, but the steels failed to agree among themselves, and the irons showed no agreement when considered by themselves."

It may be added that these conclusions have been reached by other investigators, working independently. After all, it appears that, no matter whether one is testing pipe or paint or almost anything else, an actual service test is the only really reliable criterion of merit, or lack of merit.

Viewing impartially all of the data presented so far, there seems to be

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little to choose between wrought-iron and steel pipe on the whole, as regards their resistance to corrosive influences, but one point may be mentioned with reference to the manner in which these materials corrode: With steel the rusting takes place more or less uniformly over the surface, while wrought iron shows a decided inclination to form deep pits. That this is a dangerous tendency can hardly be doubted.

In the course of the investigation mentioned above, Dr. Walker found that in the most corroded samples, these being practically worthless, the average depth of pitting was 0.130 of an inch for the iron, and 0.118 for the steel. Likewise, it was found that of twenty-six samples of iron pipe removed from the hot-water boiler-feed lines in the power plants of the H. C. Frick Coke Co., the average of the deepest pit in each was 0.112 of an inch, while the average of twenty-six steel samples taken from the same lines was 0.108. Of course, these differences are not at all startling, but they would seem to indicate a weak point in wrought pipe.

DISTRIBUTING OVERHEAD EXPENSE

By Nicholas Thiel Ficker

VI. DEPRECIATION, INSURANCE, TAXES, AND INTEREST, TOOL, MATERIAL, AND SPECIAL DEPARTMENT EXPENSE

Mr. Ficker has discussed in previous chapters of this series, which began in the June issue, first the general errors in applying manufacturing expense to costs of production; second, the two main divisions—machine expense and material expense; third, the classification and interpretation of general ledger accounts; fourth, the segregation and distribution of power expense, and fifth, the proportionment and distribution of rent expense. This chapter will be followed by others on the machine unit system and current variation ratios.—THE EDITORS.

IN our analysis of manufacturing expense we have thus far considered administration, power, and rent charges. We found that these divisions of expense were distributable to costs of production on the basis of employees, units of power consumed, and floor space occupied respectively.

Under the classification "Fixed Charges" were included Depreciation, Insurance, and Taxes. These charges are computed and distributed to production centers on the basis of *face values*, which, as will be noted by the reader, forms a basis distinct from any thus far considered. The importance of correctly classifying additions to the factory plant accounts, on which point the writer laid considerable stress in an earlier chapter, will now be fully appreciated; as it will be seen that the face values of the factory equipment, as indicated by the respective plant accounts on the general ledger of the company, control the extent of the expense charges for which they are used as a basis of computation.

Of the three divisions under the head of Fixed Charges, depreciation is by far the most important from a cost standpoint. Until such time as a standard method of computing depreciation has been established and adopted, this important part of manufacturing expense will continue to perplex and confound manufacturers and accountants, probably more than all the other

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phases of cost accounting combined.

Some manufacturers set aside reserves for depreciation, according to fixed rules, while others set them aside according to the state of their digestion. This latter statement is far from idle jest. A board of directors, with which the writer had occasion to be thrown in contact several years ago, set aside each year a reserve for "depreciation" which was later charged against the manufacturing branch of the company and assimilated in their cost of production. The amount varied in proportion to the profits of the company for the preceding year, and, to a great extent, on the state of mind of the officials at the time of these annual meetings. That depreciation formed a most vital part of their cost of manufacture had not entered the minds of these men, and yet they expected to use their shop costs as a basis for determining selling prices.

The determination of depreciation rates is mostly a matter of estimate. Any scheme of depreciation must therefore be necessarily founded on an estimate of the life of the plant under consideration. Depreciation must represent to the manufacturer the difference between the cost of the property and its liquidation value when it becomes useless to him. This period of usefulness is governed by two factors, "actual wear and tear," and "possible obsolescence due to improvement in the art." No one would advocate writing off the same amount of depreciation on a flying machine motor as on a motor in ordinary commercial application, for the simple reason that the rapid improvement in the design and construction of motors for driving aircraft has made it necessary to discard former types long before they have become worn out through actual usage. Certain types of automatic screw machines having a natural life of between fifteen and twenty years were replaced in a plant known to the writer at the end of three years by machines so much more efficient that the loss incurred in discarding the earlier machines would be more than made up through the operation of the improved type. Types of buildings have also been known to change, although not so rapidly as in the case of machines and fixtures. Obsolescence is therefore a very important factor from a depreciation standpoint, and one which must be given careful consideration when establishing rates.

Since depreciation is so dependent on variable factors, is so much a matter of estimate and even conjecture, the question has naturally been raised, Why not set aside each year a sum which will be adequate to meet all needs and in this way eliminate all fussing with depreciation, amounts, and rates? This scheme would be perfectly logical were it not for the fact that it does not take into consideration the effect on operating costs. Depreciation is a real expense just as much as power, rent, and taxes, and every administrative head should understand that it is something more than simply a bookkeeping transaction. When we stop to consider that in the average machine shop the charge to manufacturing expense for depreciation on grounds, buildings, machinery, and tools, when computed at fair rates, amounts to about one-third of the manufacturing expense, an idea of its effect on shop costs will be more readily appreciated.

A factory and its equipment represent a complex entity made up of units varying in degree of importance from a file to a building. The file is soon destroyed while the building may last for generations, but in the final analysis they are both perishable tools. Between these extremes

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lies, therefore, a continuous line of equipment, each item of which contributes with its own life to the product of the factory. Three factors govern any depreciation scheme:

First—The length of time the property is to be used;

Second—The liquidation value at the end of that period;

Third—The method of creating a reserve to take care of this depreciation; that is, whether uniform or varying amounts shall be set aside annually.

It is obvious that the several estimates which have to be made and used as the basis of any depreciation scheme must naturally be based on a combination of experience and conjecture. It is a lamentable fact that more data on depreciation of properties is not available for standardization purposes, as this would be of material assistance in establishing rates. However, the fact remains that any scheme relying on estimates for its success will rarely, if ever, turn out to be absolutely correct. We must, therefore, make use of what data is available and apply it in a reasonable way to the problems under consideration. Depreciation is too often looked upon as a loss; yet one of the first laws of economics teaches us that "production without consumption cannot exist," hence, "depreciation of the plant" means to a reasonable extent "appreciation of the product."

Considering the three factors of any depreciation scheme, in the order above stated, the first is that of "time."

1. The "life" of any property from an operating standpoint is, as has been stated, dependent on wear and tear, and on obsolescence. In some instances wear and tear may be entirely offset by repairs and replacement of parts, as is found in the case of railroads. In manufacturing establishments, however, the procedure is usually to make repairs as they are needed, but to make no regular and extensive replacement of parts.

2. The "liquidation value" of a plant is effected to a large extent on its adaptability for other uses and to its possible increment, as in the case of city properties. At best, however, the liquidation value of the average plant at the end of its useful life is little more than scrap value, and in its worst phase it sometimes involves considerable expense in order to get rid of worthless property.

3. The "method" of computing depreciation derives its importance from its possible effect on operating costs. It is sound business practice to approach liquidation value as rapidly as possible; it is also good policy to know the real value of property when making up tax reports or when placing insurance; but it is vitally important that the effect on costs of production resulting from any depreciation reserve scheme that may be adopted, must be applied with due regard to its effect on these costs.

The argument in favor of writing off depreciation on the basis of diminishing rather than original values is well taken, for the reason that during the early life of a property, when the reserve for depreciation would be high by this method, the repairs would be negligible, while during the later period of its usefulness the smaller reserve would be offset by higher repair charges. Therefore, by applying rates of depreciation on net values of plant and thereby making the charge to expense lighter towards the end of the life of the property, the effect on operating costs would be more or less equalized for all periods. It is generally true that the efficiency of a plant decreases as the plant grows older and it would seem reasonable to have the depreciation

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charge to manufacturing expense less when repairs are increasing.

Some plants have adopted what is known as the "Depreciation-Repair Reserve" method, which consists of estimating the probable life of property and the repairs for that period. By adding these repairs to the amount for depreciation and by dividing this total by the estimated number of years, a flat charge is made to manufacturing expense each year to cover all repairs and depreciation. Any increase or decrease for that period is adjusted through a special adjustment account provided for that purpose. This method has some good points in its favor, but does not really simplify matters as much as it would seem to on first consideration, because of the constant adjustments which would have to be made for new equipment purchases and for equipment sold or junked.

The English practice in arriving at depreciation rates on buildings is to consider the value of a building to be always worth at least twenty-five per cent of its original cost. This procedure is not in accord with the usual practice of American manufacturers and engineers, who take an entirely different viewpoint. In England where many of the buildings are over a hundred years old a building is considered as something permanent even if it only consists of walls, roof, and floors, so long as the floors can carry a load. The rates of depreciation on buildings which they use average only about one-half of one per cent. That buildings are sometimes too permanent does not seem to enter into their method of calculation. By charging too low a rate for depreciation, and by paying out profits according to the state of their accounts, English manufacturers often find it necessary to take in new capital in order to bring their equipment up as modern requirements. That this usually results in hardship will be readily appreciated, and the English practice has been justly criticized for it.

A very good illustration of the fact that construction can at times be too permanent can be found in the case of an English railroad between London and Liverpool which was built many years ago and was laid out with the intention of using only small freight cars with a ten-ton capacity limit. Owing to the fact that all cuts, tunnels, bridges, etc., were made so permanent by using masonry and stone construction throughout, the cost of rebuilding the road later on was so great as to make it prohibitive. Today, freight rates on merchandise between these two cities, a distance of approximately two hundred miles, are nearly twice that charged between New York and Chicago, a distance of almost one thousand miles. This condition is directly due to the fact that sufficient depreciation had not been provided for a possible condition such as now exists.

In American practice the following rates of depreciation on buildings and permanent fixtures devoted to manufacturing purposes, have been used with a certain degree of success:—

Buildings:—	Factories	Warehouses.
Modern fireproof steel and tile...	3 per cent	3 per cent
Mill construction..	7 " "	4 " "
Steel construction (only partly fireproof)	6 " "	3 " "
Wooden buildings, (of poor construction) 12	" "	8 " "
Permanent Fixtures:—		
Pertaining to buildings 12	" "	8 " "
Pertaining to power and lighting plants 12	" "	
Pertaining to material .....,,12	" "	

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The reason for using a lower rate of depreciation on warehouses is due to the conjecture that the wear and tear on factory buildings and permanent fixtures resulting from the constant jar of machinery will be greater than on buildings used only for storage purposes. "Permanent fixtures pertaining to power and lighting plants" are depreciated at a slightly higher rate than other permanent fixtures, on the basis that they come more or less in the same class as machinery and are therefore subject to more rapid obsolescence than other permanent fixtures.

In establishing rates of depreciation on machinery it is very seldom worth the extra trouble involved to use separate rates for each machine type. A uniform rate for all types will prove to be of much more practical value both in the simplicity of its application and in attaining the ends desired. A rate of from 7 per cent to 10 per cent on machinery is usually within reason, and rates approximating these are what are commonly used. Small tools should be written off just as rapidly as possible. Many manufactories write all tools off as soon as purchased, but as this would prove to be a hardship to new companies, a minimum of at least 15 per cent a year should be written off to be conservative. In the case of patterns, changes are even more likely to be made than in the case of tools; it is good practice to write them off entirely within two or three years.

When making ledger entries for depreciation reserves, an account called "Depreciation Reserve" should be credited and the Manufacturing (Shop) Expense Account debited. In this way the original values of the respective plant accounts will remain unchanged, except when any part may be sold or junked, in which event manufacturing expense is debited with the loss incurred.

The following form of depreciation report will show clearly just what amounts have already been set aside and how they compare in percentage form with the original values:—

DEPRECIATION REPORT

Ledger Account	Original Values	Depreciation Reserve		Net Value of Plant	Accrued Depreciation for Current Year		Cross Amount of Depreciation Reserve	Per Cent of Original Values
		Amount	Per Cent of Original Values		Rate used	Amount		
Grounds								
Buildings ...								
Perm. Fixt..								
Machinery ...								
Small Tools..								
Patterns								
Shop Fixt...								
Total Factory Plant								

Insurance and tax charges to manufacturing expense do not require much analysis. Insurable values are determined from an analysis of the plant accounts, deductions being made for such parts of the plant as foundations, piping, etc., on which no insurance is found warranted.

Some companies are carrying self-insurance on isolated risks where values do not exceed a few thousand dollars in each case. The plan is based on the assumption that where a sufficient number of such small units exist, the aggregate premiums will more than pay for the losses involved. In this way a fund is built up which will eventually be large enough so that the income therefrom will be sufficient to pay the yearly expense and losses. The building up of such a fund would naturally re-

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quire a considerable time, as fires would probably be inevitable and would tend towards retarding this building-up process. However, if the risks are carefully selected and the proper precaution used in preventing fires, a fund of this sort would finally grow to considerable proportions and dividends could probably be derived therefrom.

The important element of any such scheme of self-insurance is to run no chance of big losses and to keep as small as possible such losses which are bound to come, by keeping the risks isolated.

Having thus considered the three divisions of "Fixed Charges," depreciation, insurance and taxes respectively, the question of including interest on the factory equipment as a charge to manufacturing expense, is worthy of careful analysis and consideration.

Those accountants, including many prominent in the profession, who advocate charging to manufacturing expense, and thereby to costs of production, the interest on the investment in a factory's equipment as represented by the plant accounts on the general ledger, are subject to criticism because of the fact that they should have gone much further with their interest charge or should have discarded it entirely. By again referring to our study of economics, we find that a machine represents labor in condensed form; therefore, labor and machinery are synonymous from a production viewpoint. What right have we, then, to charge interest on the investment in the machine equipment and not charge it on the investment in labor? A cost of production is made up of labor, material, and expense; then why not also charge interest on the investment in materials and on the investment used up by shop expense?

A manufacturer has three operatives performing certain work each day. He installs an automatic machine which eliminates all three of them. Instead of the former labor being charged against the job, the cost of upkeep and depreciation on the machine is charged in place thereof. Why accountants do not advocate charging interest on the labor cost and yet believe it justifiable to charge interest on the investment in the machine, none of those to whom this aspect of the case has been presented have as yet been able to explain. The writer does not know of a single case on record where "interest," when included in costs of production, has met this objection by also including interest on all working capital.

The contention of the writer is that "interest" does not form a part of the direct cost of manufacture, but is chargeable to "profit and loss" as a financial expense. There remains, however, considerable room for discussion as to whether it is more justifiable to charge interest, when based on *all* working capital, to manufacturing rather than to financial expense; but there is certainly no excuse for including interest on only the investment in the plant to the exclusion of interest on other working capital such as is employed in labor, etc.

The segregation of "Fixed Charges" does not involve any complex system of accounting other than the establishment of a fixed policy. The aggregate of these charges for depreciation, insurance, and taxes does, however, form a large bulk of the total manufacturing expense which we are interested in distributing to costs of production; hence no policy which so vitally effects costs should be adopted without careful analysis and knowledge both as to the present and future policy of the company.

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After the "fixed charges" have been summarized for any period, transfers must then be made to the several divisions of expense on the basis of valuations, which were discussed under the subject of depreciation. This transfer is similar to the "Service Charge Transfers" made from former expense divisions. In this way these charges are finally incorporated in the cost of power, rent, tool expense, etc., and then through the distribution of these divisions of "overhead" finally get into the shop cost summary.

"Tool expense" may be defined as consisting of that portion of manufacturing expense incidental to the operation of the machine and tool equipment of the factory. The following specimen classification reference list will convey a general idea as to the expenses which are chargeable under this division of manufacturing expense.

TOOL EXPENSE CLASSIFICATION REFERENCE LIST

401—Belting for machines
402—Changes to small tool and to shop fixtures in tool stockrooms
403—Changes to machinery
404—Depreciation on machinery, tools, and shop fixtures. Transferred from "Fixed Charges"
405—Insurance on machinery, tools, and shop fixtures. Transferred from "Fixed Charges"
406—Taxes on machinery, tools, and shop fixtures. Transferred from "Fixed Charges"
407—Repairs to machinery
408—Repairs to tools
409—Repairs to patterns
410—Salaries, clerks in tool stockrooms
411—Salaries, tool inspectors
412—Salaries, machine oilers
413—Salaries, men setting up machines for operators
414—Salaries, setting up new machines
415—Stationery
416—Supplies (waste, oils, lubricants, etc.)
417—Water (other than for power or rent expense)
418—Service charges (Brought forward from administration, power, rent, etc.)
419—Transfers to other accounts

"Material Expense" may be defined as all expense incurred in purchasing, receiving, inspecting, handling, and storing all shop raw and worked materials. It is often of benefit to divide material expense according to raw and worked material expense respectively, as in this way a somewhat better control can be exercised over the various kinds of expense involved.

A considerable portion of material expense is that incurred through inspection. It might be well, therefore, to draw attention to the fact that one of the most common causes of waste is that traceable to faulty inspection. The most efficient form of inspection is possible where this work is done under the direction of a chief inspector whose sub-inspectors report directly to him instead of to department foremen. Unless this plan is followed, the inspector will, in the majority of cases, be biased in favor of the department to whose head he reports.

Material inspection may be divided into three parts—raw material inspection, worked material inspection, and finished material inspection; the two latter coming under the head of "worked material expense," as will be seen from the classification list below. Proper inspection in a manufacturing organization can do much towards curtailing manufacturing expense by detecting mistakes before useless extra labor is consumed on defective parts. It is a branch of tne manufacturing organization whose head should be a man versed in engineering practice and standards, understanding thoroughly the use of testing machines and gages, and having a working knowledge of the chemistry of metals. The following classifications show the nature of the items composing both raw and worked material expense.

RAW MATERIAL EXPENSE CLASSIFICATION REFERENCE LIST

501—Changes to patterns and to shop fixtures in raw material stockrooms
502—Changes to permanent fixtures pertaining to material

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503—Depreciation on raw material, fixtures, etc.
504—Changes
505—Insurance on raw material, fixtures, etc.
506—Taxes on raw material, fixtures, etc.
507—Repairs
508—Salaries, clerks on raw material
509—Salaries, receiving department
510—Salaries, inspectors of raw material
511—Salaries, raw material stock keepers
512—Salaries, freight elevator operators (part)
513—Salaries, raw material porters
514—Stationery
515—Unclassified raw material expense
516—Testing expense (including laboratory work, etc.)
517—Service charges (Brought forward from administration, power, rent, etc.)

WORKED MATERIAL EXPENSE

551—Changes to shop fixtures in worked and finished material stockrooms
552—Changes to permanent fixtures, worked material, etc.
553—Depreciation on permanent fixtures, worked material, etc.
554—Insurance on investment in process material and on fixtures
555—Taxes on investment in process material and on fixtures
556—Railway expense (where sidings, etc., are used)
557—Repairs to shop fixtures in worked and finished material stockrooms
558—Repairs to shop and permanent fixtures in worked and finished material stockrooms
559—Salaries, clerks on worked and finished material stock-records
560—Salaries, stock keepers
561—Salaries, porters on worked and finished material
562—Salaries, cranemen
563—Salaries, counters
564—Salaries, inspectors of worked and finished material
565—Salaries, freight elevator operators (part of total chargeable to worked material)
566—Stationery
567—Unclassified worked material expense
568—Wrapping paper, cartons, boxes, etc.
569—Service charges (Brought forward from administration, power, rent, etc.)

As we are interested in closing out all manufacturing expense finally into either machine expense or material expense, it naturally follows that the balances to both raw and worked material expense will be closed out into material expense and will be applied to shop costs as a loading distinct from the machine expense loading. The component charges to these two main divisions of manufacturing expense can be analyzed at a glance from the following:

MANUFACTURING EXPENSE		MACHINE EXPENSE	MATERIAL EXPENSE
Administration	Expense	Part	Part
Power	"	Part	Part
Rent	"	Part	Part
Fixed Charges	"	Part	Part
Tool	"	All	None
Raw and Worked Material	"	None	All

It very often occurs that certain so-called "Special Departments" use expense supplies and materials of such a nature that they form practically the bulk of the manufacturing expense chargeable against such departments. This is especially true in such instances as brass and iron foundries, dipping and plating departments, and enamelling, lacquering, painting, and finishing departments. The nature of the expense in such instances is usually so specific that separate expense loadings are used for these departments to the exclusion of the general machine expense loading. In other words, these special departments are treated as though they were single producing units rather than a collection of units as found in the general shop. The segregation of such departments should only be made, however, when the nature of the work done by them is of a very specific nature.

We have now analyzed all of the elements of manufacturing expense and are now ready to take up the question of distribution to production costs. The main part of this expense as we have found, is that known as "Machine Expense." In the following chapter the distribution of this expense through what is known as the "Machine Unit System" will be discussed in detail.

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RECORDING POWER PLANT OPERATIONS

By Julian C. Smallwood

III. PRESSURE AND VACUUM GAGES, TEMPERATURE, TIME, AND SPEED RECORDERS

In the two chapters that have preceded this Professor Smallwood has described the fields of usefulness, the general characteristics, and the construction of coal, water-flow, and steam-flow meters, and CO_2 recorders, draft gages, and Blonck efficiency meters. A final paper to appear next month will be devoted to the study of the records obtained by the various recording instruments.—THE EDITORS.

IT is perhaps worthy of note that autographic apparatus for minor purposes in the power plant has reached a state of approximate standardization. This is evidenced by the fact that manufacturers of such are now bending their energies to the improvement of details instead of to the development of operating principles. Consequently, we shall find in certain classes of recorders, such as for pressure, temperature, etc., a few standard forms despite the fact that there are many makes. It is as though the art of autographic measurement had, in the initial directions, simmered down to a substantial and well-tried residue; whereas, in the case of such instruments as for steam and water flow, CO_2, and so forth (in which, it may have been observed, the operating principles are very diverse), the development is still in the process of boiling.

Although pressure and temperature recorders have just been referred to as of minor importance, yet such importance as they have is of no small amount. This is particularly true of thermometers, the applications of which are as varied as they are valuable.

In power plants such as we have been considering, the raw materials are coal and water, and the finished product is power; but the working medium is heat. In a previous chapter we have seen how the raw materials may be recorded, and we have also seen how graphic measurements of one element (weight) of the working medium may be made. In heat determinations, the temperature element is of scarcely less importance than the weight. For instance, if we know that a certain proportion of our feed water has disappeared through leakage, we may form only an approximate estimate of what the loss is in terms of B.t.u. and from this the loss in pounds of coal or dollars. To form a correct idea of the loss we must know whether the H_2O disappeared as water or steam, as, for example, through a leaky blow-off or trap; and, furthermore, we must know something about its temperature condition relative to that of the feed water. From this consideration, and from the fact that thermometers are of supreme importance to the regulation and the efficiency measurement of certain auxiliaries, it follows that this class of recorder should have a conspicuous place in the power plant.

Regarding the recording of the finished product—power—there are to be classed, the steam engine indicator,

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dynamometers, and switchboard instruments when the final product is current. The first of these is rather too commonplace and much used an appliance to receive detailed attention here, although some of the continuous forms would not be without interest. Dynamometers come under the head of manufacturing rather than the power plant proper, and electrical instruments occupy a field of their own. There remains to consider, then, a few recorders of un-

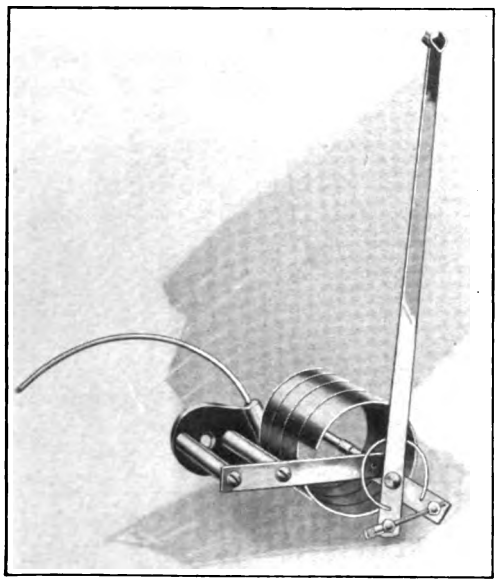

FIG. 1. MECHANISM OF FOXBORO PRESSURE RECORDER

doubted utility although not strictly necessary, such as time recorders. Let us, however, first take up

PRESSURE AND VACUUM GAGES

The most important function of these pertains to regulation. This point is too well recognized to need amplification here. Aside from this, pressure recorders simplify the work involved in the occasional testing of engines or boilers. When figuring boiler horsepower, or equivalent evaporation, rough estimates for the number of pounds of steam per horsepower or for the factor of

FIG. 2. FOXBORO RECORDING PRESSURE GAGE

evaporation are customarily used, these being based on a supposedly constant working pressure. This is close enough for purposes of comparison of daily performance, but for more accurate trials there should be measured the actual average pressure. A further use of pressure recorders is the detection of leaks in branch lines supposedly shut off in night hours. There are also minor occasional services, such as the recording of the time of operation of a steam blower from which an estimate of the steam used may be made.

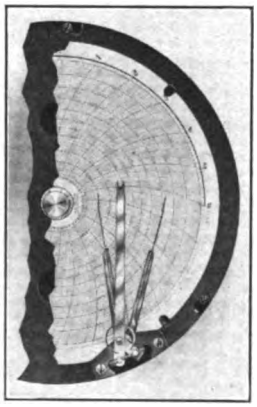

FIG. 3. FOXBORO HIGH AND LOW ALARM ATTACHMENT

Vacuum recorders are invaluable for the regulation and efficient operation of condensers and the engines exhausting into them. This is especially true in the case of steam turbines with which a small change in the back pressure means a decided loss in efficiency.

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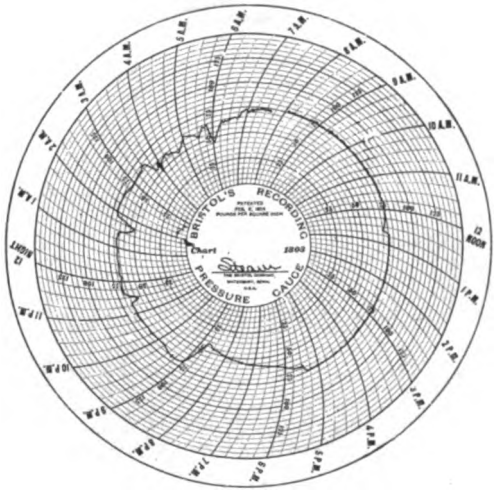

FIG. 4. PRESSURE RECORD SHOWING GOOD AND POOR REGULATION

Pressure gages of the recording type are mechanically superior to the old time gage because of the elimination of link work. This introduces lost motion and friction and results in errors, which, although inappreciable in connection with some purposes, are of decided magnitude. Recording gages tested by the author have shown no perceptible difference in the indications corresponding to an increasing or a decreasing pressure, showing that the frictional resistance or lag of these instruments is small.

The working principle, generally, is that of the Bourdon tube, the only difference being that the tube is helical in form instead of circular. (Figure 1). Thus a sufficient motion of the free end of the tube, to which the pen arm is attached, is provided for without the necessity of magnification as with the ordinary pressure gage. Figure 2 shows the assembled arrangement of the Foxboro gage which is identical in principle to numerous other makes. This might be called the standard form for pressures above about ten pounds. Lower than this, the diaphragm type of gage, discussed under the head of Draft Gages, is employed. It is the latter type in the main which is used for vacua measurements.

Figure 3 shows an attachment which has been applied to other as well as pressure recorders, namely, a high and low alarm. This works by electrical contact of the recorder arm, and causes a bell to ring and thereby apprises the fireman (and others) that the pressure is outside of the desired limits.

Figure 4 is a typical pressure record. It will be noted that the night shift was less attentive to the maintenance of uniform pressure than the day shift.

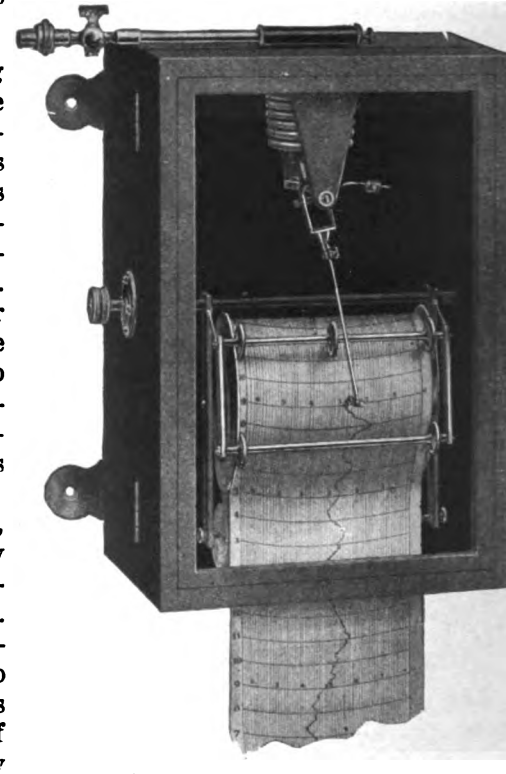

FIG. 5. PRECISION RECORDING GAGE

A pressure gage yielding records of the tape form is represented by Figure 5. The paper is sufficient in length to last for 60 days, and may be torn off conveniently after any chosen interval. As with the disc chart gages, this works on the Bour-

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don tube and diaphragm principles.

A vacuum gage of entirely different working is illustrated by Figure 6. This is nothing more nor less than a mercury U-tube, one leg of which is considerably larger in diameter than the other. The mercury, therefore, rises in the leg of small diameter (to which the vacuum is connected) more than it falls in the large one. In the latter is a metal float carrying the pen arm which thus has a motion corresponding to that of the mercury. An advantage of this instrument is that there is no possibility of error from the deterioration of spring metal, which sometimes occurs (through overheating or straining) in Bourdon tubes or diaphragms.

When testing turbine performance considerable error may result from reckoning the absolute back pressure as the difference between a vacuum gage indication and the normal barometer height, that is, 30 inches of mercury, since any variation of atmospheric pressure from normal will make the true back pressure different from the reckoned. For such performance tests barometer readings should always be secured. To satisfy this requirement the Uehling Company has produced a combined recording vacuum gage and barometer (Figure 7). This operates in the same manner as their vacuum gage. The absolute back pressure may be obtained directly from the record by taking the radial distance from the atmosphere line as a datum to the back pressure line.

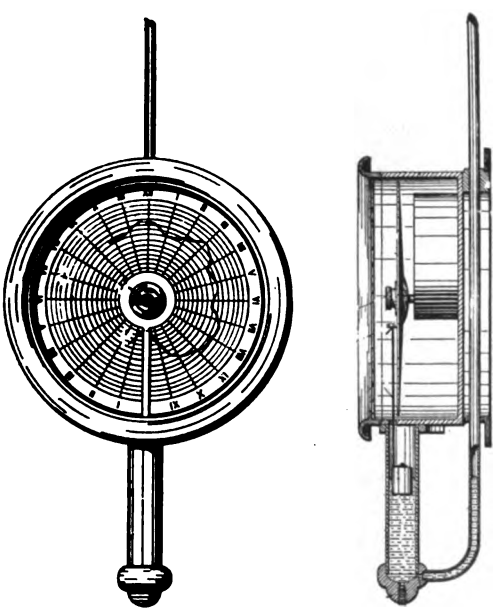

FIG. 6. UEHLING VACUUM RECORDER

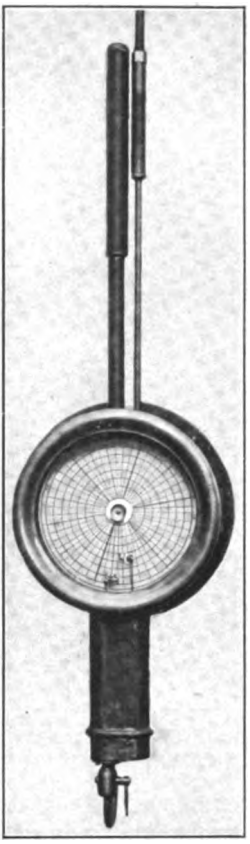

FIG. 7. UEHLING VACUUM GAGE AND BAROMETER

Temperature Recorders

Ordinarily, a sort of loose distinction is made between the terms pyrometer and thermometer in that the former is supposed to be a high-reading form of the latter. At one time there was some justification for this distinction as the operating principle of a low-reading instrument was radically different from the high-reading. Now-a-days, however, a temperature recorder of a given type may be applied to high or low ranges without any change in the form of the instrument. On this account, the nomenclature appears ludicrous, especially in consideration of the fact that the particular temperature at which the measuring instrument ceases to be a thermometer and be-

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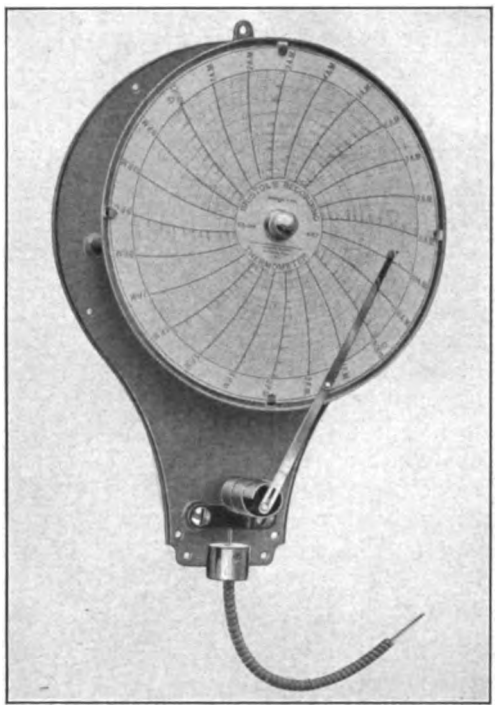

FIG. 8. MECHANISM OF THE BRISTOL RECORDING THERMOMETER. A USUAL TYPE

comes a pyrometer has never been specified. The writer prefers to call all temperature measuring devices thermometers, although, it must be admitted, the association of the term pyrometer with such instruments as the thermo-electric couple is strong. It would perhaps be best to apply the name pyrometer only to those devices that are used exclusively for temperatures of flaming or incandescing bodies.

The most important applications of power plant thermometers are towards the determination of feed-water and flue-gas temperatures. Feed-water heat data are needed if boiler performance is to be accurately computed. Of greater value than this, however, is the regulation of feed-water temperatures which is a natural result of complete records. A striking example of this is given by Figure 9. As for flue-gas temperatures, the necessity for their records was mentioned in a previous chapter in connection with CO_2 recorders. Other usual thermometric records lead to the following: the determination of feed-water heater performance, for which thermometers in the in-going and out-going streams are

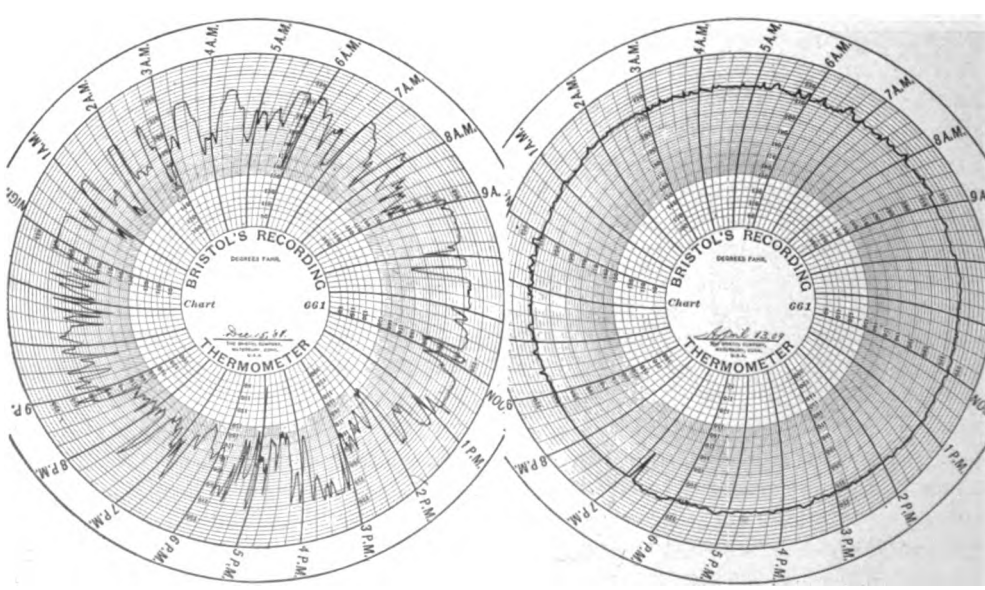

FIG. 9. FEED WATER RECORDS FROM A BRISTOL RECORDING THERMOMETER
Showing the old and the new conditions of regulation

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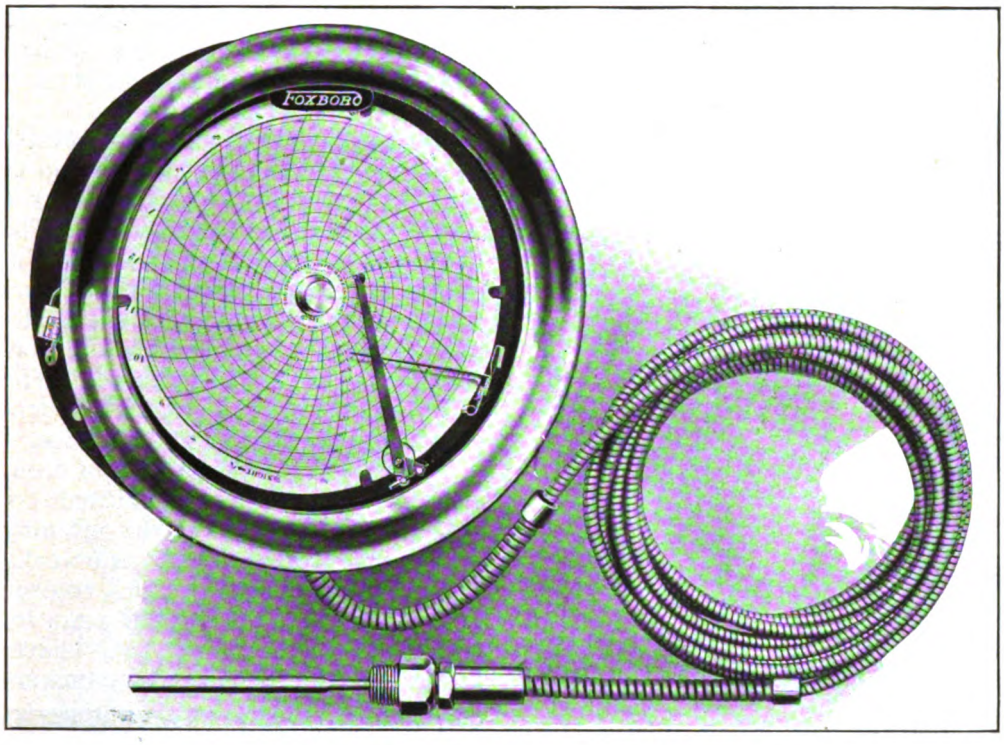

FIG. 10. FOXBORO RECORDING THERMOMETER

needed; the determination of economizer performance, for which initial and final temperatures of gases and feed-water should be taken; the quality of superheated steam, the measurement of which, in plants using it, is as desirable as that of pressure, and the many determinations of heat wastes such as from radiation of pipe lines.

The familiar disc-chart recording thermometer is of the "constant-volume" type, and in reality is simply a pressure gage (see Figure 8). The helical tube of the gage is connected by means of a flexible tube of small internal diameter to a bulb (Figure 10), and this whole closed system is filled with the thermometric medium. Upon heating the bulb the pressure of the medium is raised, transmitted to the helical tube, and recorded in terms of temperature. The working medium usually is a liquid for low temperatures, a vapor for medium, and a perfect gas for high. It is understood that by low is meant room temperatures at the minimum, and by high is meant flue-gas temperatures at the maximum.

Liquid and gaseous thermometers employ charts with uniform scales, but the graduations of the vapor thermometers increase with the range. This follows from the laws controlling the relation of pressure and temperature of the media. The increasing scale is sometimes an advantage in that the range may be chosen so that the working temperature falls on an open scale and permits accurate and easy reading. On the other hand, charts with increasing scales may not be accurately integrated by planimeter.

The vapor thermometers have the advantage that they are unaffected by changes of temperature of the

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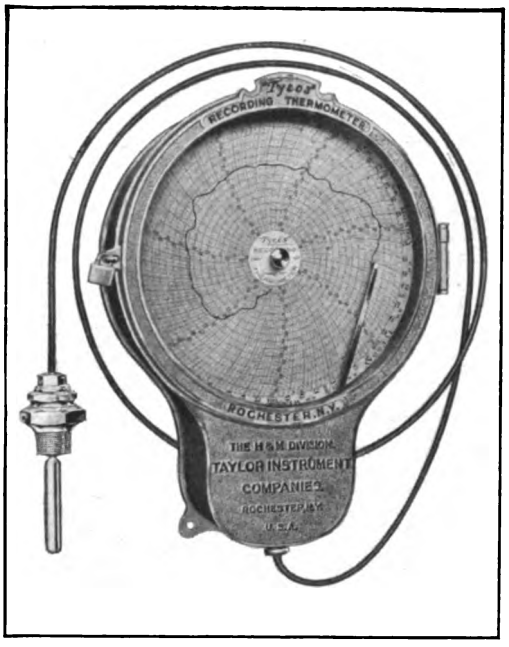

FIG. 11. TYCOS RECORDING AND INDEX THERMOMETER

flexible tube so long as it is of lower temperature than the bulb. This follows from the fact that the vapor is always in a saturated condition as the bulb contains a liquid, and that radiation of heat from the flexible tube may make the vapor wet but will not alter its pressure.

Liquid and gaseous thermometers are subject to error through changes of temperature of the flexible connector. This is obviated to some extent by making the ratio of bulb volume to tube volume large. The Bristol thermometer employs also a compensator in the form of an auxiliary Bourdon tube to counteract the effects of temperature at the recorder.

The Tycos thermometer, made by the Taylor Instrument Companies, uses mercury as a medium for all ranges up to 1000 degrees Fahrenheit. Changes of temperature at the recorder are provided for by a compensator, and at the flexible tube by reducing the volume of mercury, not only by the use of a very small bore but by running a fine wire through it. The sensitive bulb (Figures 11 and 11a) of this type of thermometer is comparatively small.

Figure 9 gives a good idea of the improvement that may be effected in feed-water regulation through the use of a recording thermometer. The chart on the left, taken just after installation, shows, besides rapid fluctuations over a range of about 50 degrees, that the temperature only occasionally reached 212 degrees. The other chart shows a practically constant temperature of 212 degrees.

Figure 12 reproduces a set of economizer records showing efficient operation by the fact that the outgoing gases and water are at practically the same temperature. Such records as these may be taken with some instruments in pairs on two charts instead of four. The Foxboro makers

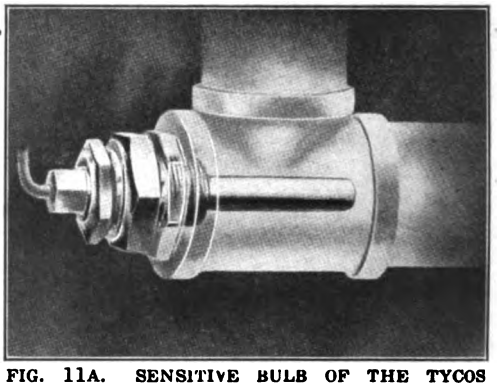

FIG. 11A. SENSITIVE BULB OF THE TYCOS THERMOMETER

have produced an instrument to accomplish this.

Figure 13 is a flue-gas temperature record which shows the conditions prevailing during a banked fire as well as when steaming.

A temperature recorder of unique principle suitable for the measurement of flue-gas temperatures is made by the Uehling Instrument Co. Briefly its operation is as follows: The gas, whose temperature is to be measured, is drawn through an ori-

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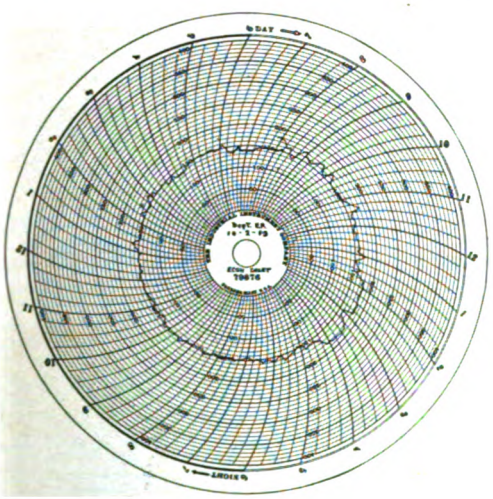
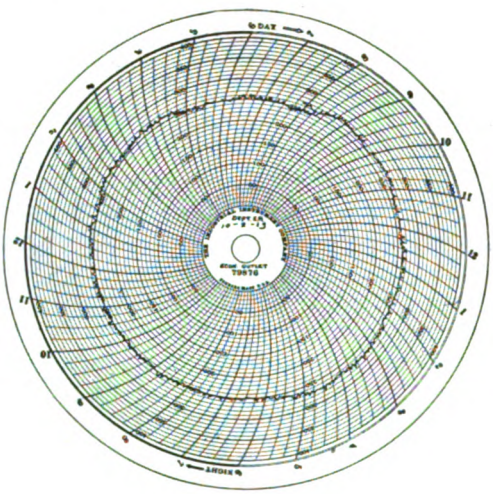
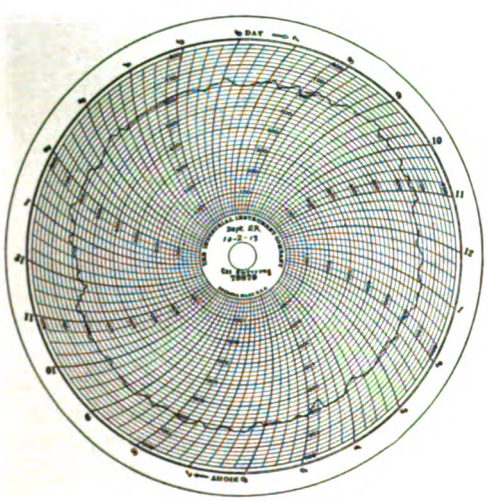
fice *A*, Figure 14, by means of a steam aspirator of a constant suction. If the gas temperatures at the two orifices, *A* and *B*, are the same, the velocities at these points are the same, and the suction required to produce the flow through *A* will be the same as that through *B*. Consequently, the suction in chamber *C* under this condition is half the total suction produced by the aspirator. If, however, the gas is expanded by heat at the orifice *A*, and cooled at *B*, the volume and velocity at *A* will be greater than at *B*, and a greater suction in the chamber *C* will be required to maintain the flow. Thus the pressure in the chamber *C* becomes a measure of the temperature of the gas, provided that the gas is cooled to a uniform temperature at *B* and that the suction of the aspirator is constant. The first item is accomplished by jacketing the orifice with



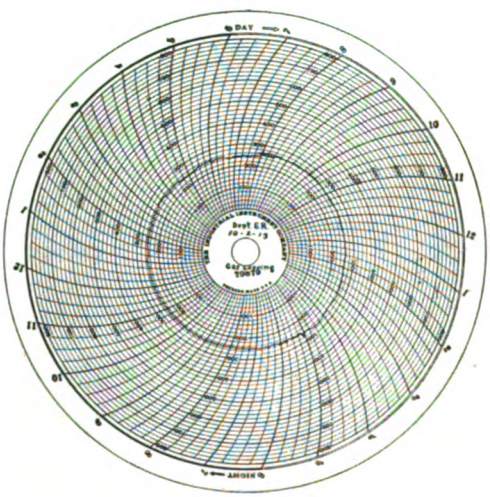
Water Entering



Water Leaving



Gases Entering



Gases Leaving

FIG. 12. FUEL ECONOMIZER RECORDS FROM A FOXBORO RECORDING THERMOMETER

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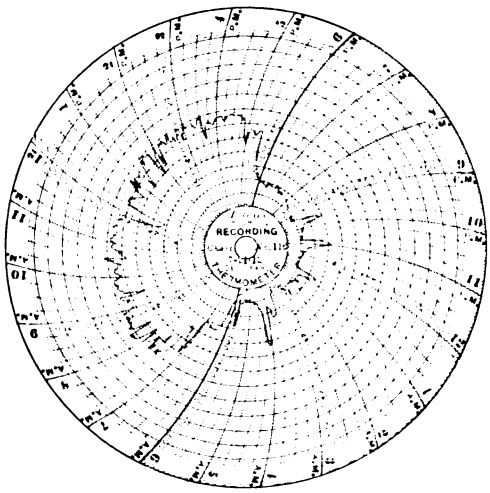

FIG. 13. RECORD FROM A TAYLOR INSTRUMENT COMPANIES THERMOMETER

condensed steam at atmospheric pressure; the second, by the use of an ingenious regulator of the steam supplying the aspirator. Temperatures are recorded by a low-pressure recording gage. Besides being made in single units, this instrument is made in combination with the Uehling CO_2 recorder so as to record CO_2 percentage and flue-gas temperature on the same chart; it is also made in multiple units, in which case one regulator takes care of all. Figure 15 is a photographic view of the device.

Pyrometers employing thermocouples have generally been applied

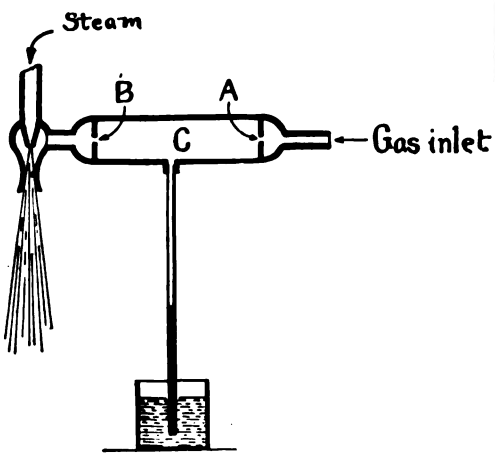

FIG. 14. DIAGRAM OF UEHLING PYROMETER

to higher temperatures than prevail in the power plant, except for the comparatively rare cases in which furnace temperatures are sought, yet they are to some extent used for the determination of flue-gas temperatures. For this purpose base metal thermo-couples are employed. It is a more expensive type of instrument than most of the others which are

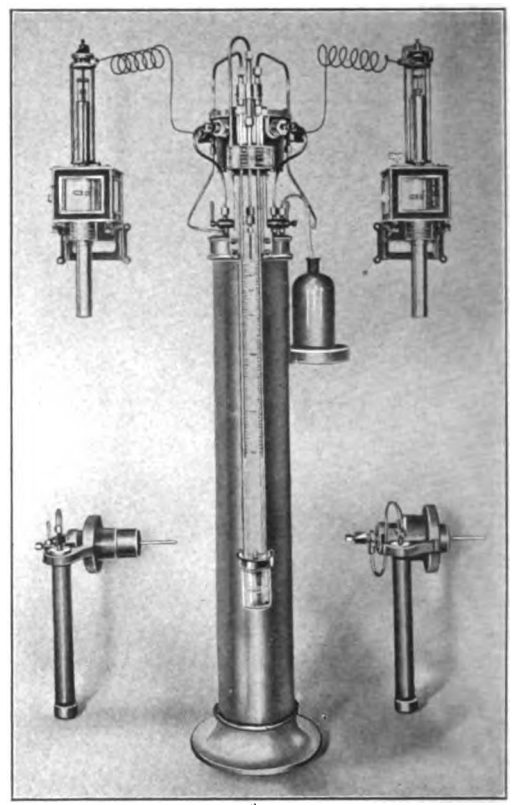

FIG. 15. UEHLING DOUBLE PYROMETER, SHOWING FIRE TUBES, RECORDING GAGES, AND INDICATOR

used for this service, but on the other hand it has a certain flexibility which is sometimes found desirable. Thus, a single recorder remotely placed will serve a whole battery of boilers by the use of a simple switch, if it is desired to take only occasional records from each. Figure 16 is illustrative of one of these instruments made by the Brown Instrument Co.

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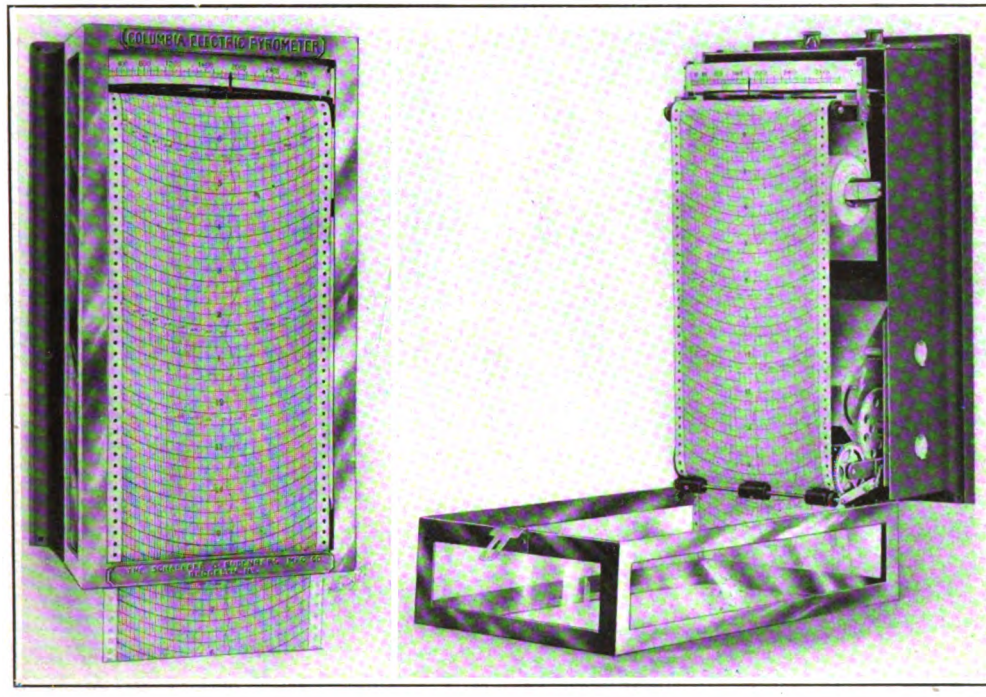

FIG. 16. BROWN ELECTRIC TEMPERATURE RECORDER

The galvanometer, it will be noted, is at the top of the instrument, and the one arm serves as pen holder and as an indicating pointer. The manufacturers have announced that they are about to produce a similar recorder to give multiple records.

TIME RECORDERS

Under this head we come to a class of instruments which, although exceedingly simple in fundamental principle, are very interesting in their wide possibilities and the disclosures they yield. There are two forms in common use, referred to, not very appropriately, as "mechanical" and "electrical." The function of each is to record the time at which a given operation occurs or is completed. The electrical recorder takes count only of the *time* of the operation; the mechanical recorder does this also and further records the *extent* of the motion involved. The working of the latter apparatus may be understood from a study of Figure 17a. The lever projecting from the bottom is attached to the mechanism whose motion is to be measured and timed—let us say, for example, a furnace damper—so that the motion of the lever is proportional to the damper opening. The position of the pen then indicates the amount of damper opening and the time and duration of changes of opening.

The applications of mechanical time recorders in the steam power plant are more limited than of the electrical. In water power plants they have been used extensively for the recording of the time and amount of turbine gate openings. In steam power plants they will be found exceptionally useful for occasional purposes. For instance, they have been applied to relief valves on heating systems for the obtaining of approximate data upon the amount of steam lost through the exhaust head. Similarly, the action of a boiler safety valve may be studied and the strokes

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FIG. 17A. BRISTOL MECHANICAL TIME RECORDER

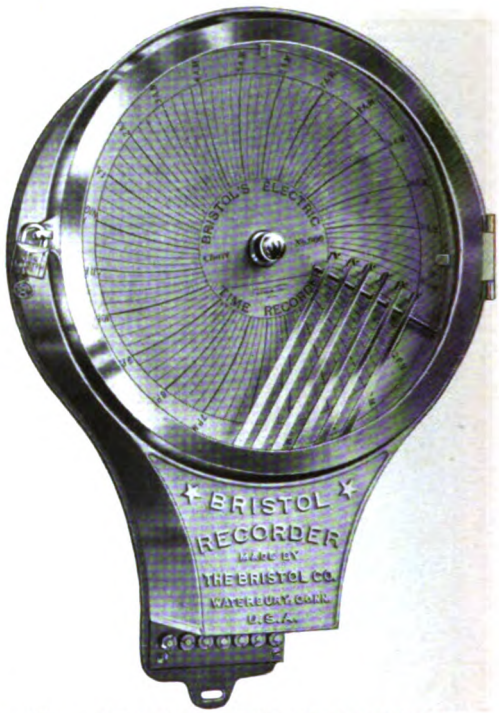

FIG. 17B. BRISTOL ELECTRIC TIME RECORDER

of pumps may be measured and timed.

The electrical time recorder is arranged so that a short pen stroke is made on the chart upon the completion of an electrical circuit. The circuit is closed by a contact piece actuated by a reciprocating or revolving member of the apparatus to be timed. A great advantage of this type of time recorder is that a number of different operations may be recorded on the same chart. The

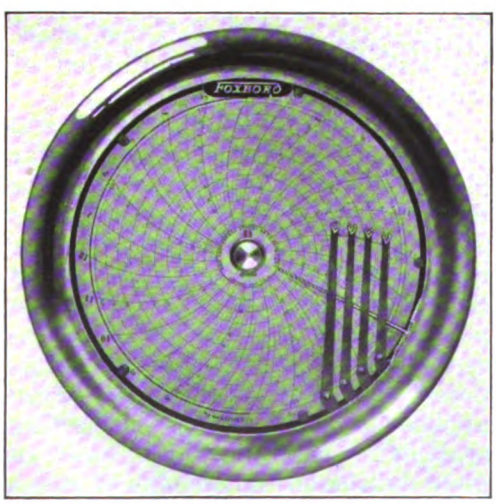

FIG. 18. FOXBORO ELECTRIC TIME RECORDER

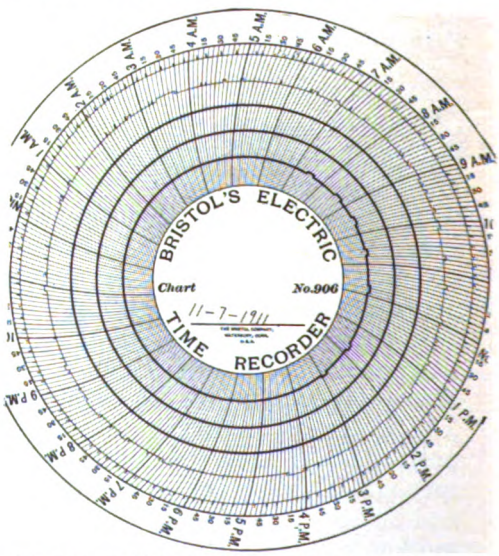

FIG. 19. RECORD FROM BRISTOL TIME RECORDER

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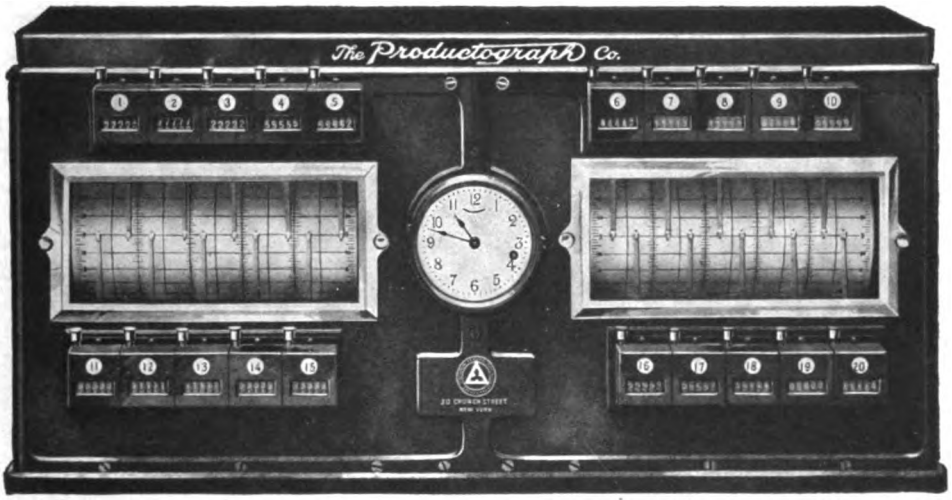

FIG. 20. "PRODUCTOGRAPH" ELECTRIC TIME RECORDER

Bristol time recorder, Figure 17b, can accommodate as many as six; the Foxboro, Figure 18, twelve. The applications are very numerous. Used in connection with mechanical stokers, a very satisfactory and accurate form of coal meter may be had. It is possible to calibrate mechanical stokers to about two per cent of accuracy in metering the coal; the time recorder will show the rate of feeding by the number of pen strokes made in a unit of time. In a similar way, the operation of ash conveyors may be put on record. A rough estimate of feed water may be had if the pump strokes are recorded. The valve reversals of the Hammond displacement water meter are counted and timed by a Bristol recorder; similarly, any ordinary registering water meter of the volume or displacement type may be converted into an autographic instrument. Another common application is the timing of the closing of feeder circuits and the opening of circuit breakers.

A good example of the different data obtainable on one chart is shown by Figure 19. In this the strokes on the outer circle show the consumption of 100 cubic feet of feed water; on the second circle, the passing of 1000 pounds of coal to the stokers; on the third, switchboard circuit-breaker openings; on the fourth, a drop of hydraulic pressure for eleva-

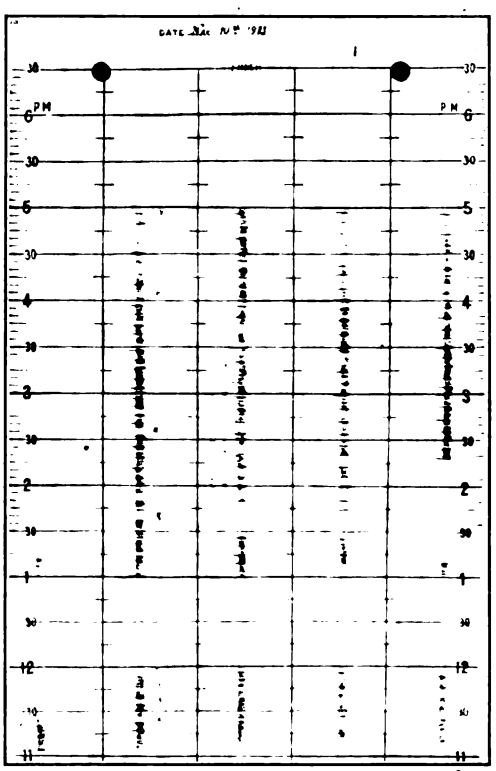

FIG. 21. PRODUCTOGRAPH RECORD

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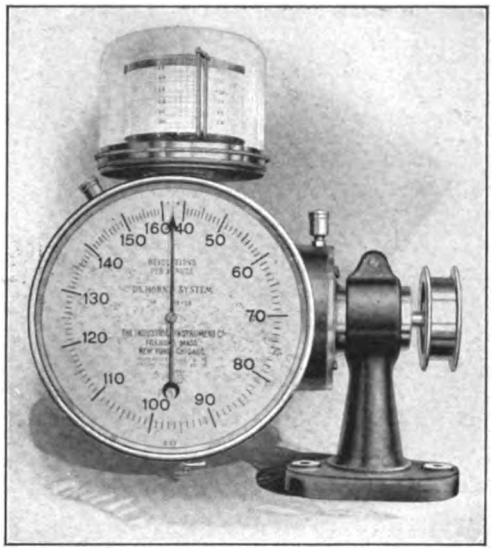

FIG. 22. FOXBORO (HORN) RECORDING TACHOMETER

tor service; and on the last the operation of the ash conveyor.

Figure 20 represents the Productograph, a time recorder which has been applied more to factory than to power plant purposes. It is, however, applicable to the latter. Each pen (as many as twenty may be obtained with a single machine) is supplied with a counter showing the total number of strokes in clear figures. It is also arranged that each tenth pen stroke, or multiple thereof, shall be longer than the others to facilitate counting (Figure 21).

It will readily be seen that the possibilities of time recorders in general are almost endless, as there are such a vast number of occasional services facilitating the study and improvement of minor power plant apparatus, as well as the adaptations for continuous service for which more expensive recorders would be needed.

Rotary Speed Recorders

This subject, strictly speaking, pertains to the factory rather than the power plant. Tachometers are, however, useful for the occasional testing of engines and auxiliaries; and, in turbine plants, continuous speed records are valuable.

As an example of the old style tachometer in which centrifugal force acts on metallic weights, the Horn instrument is representative (Figure 22). On account of the fact that it necessarily depends on links and gears, involving wear at high speeds, this type of tachometer is not well adapted to continuous and severe service.

It is probably owing to this that there should be such a radical departure from original principles as is met with in the electrical speed recorder. This device consists of a small generator driven by the shaft whose speed is to be measured. Variations are evidenced by changes of the generator voltage which is recorded in terms of revolutions per minute. An interesting thing about this tachometer is that it is one of the few that do not employ centrifugal force

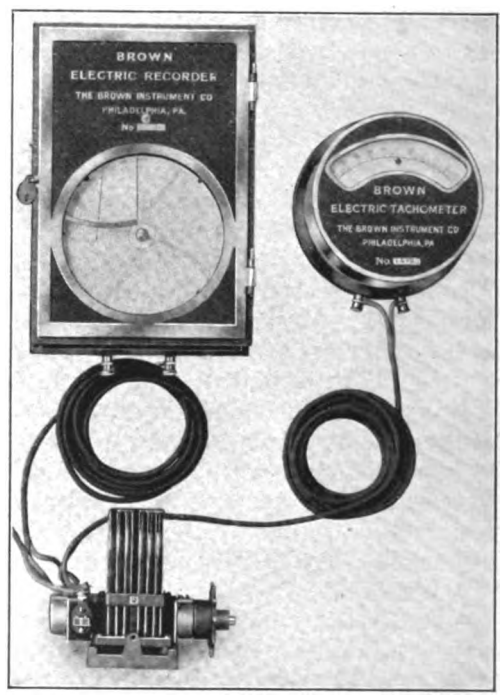

FIG. 23. BROWN ELECTRIC RECORDING TACHOMETER, WITH INDICATOR

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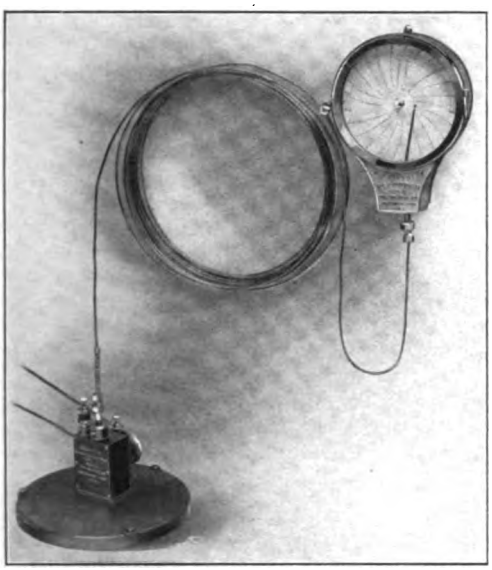

FIG. 24. BRISTOL RECORDING TACHOMETER

in one form or another. Its advantages are those which electrical instruments in general have over mechanical, especially in that it is not apt to become erroneous with use and wear. Figure 23 represents a high grade product of this class.

The action of centrifugal force on a fluid has been a promising principle to tachometer designers, in that the wear, friction, and consequent error of link work and gears are thereby avoided. The Bristol recording tachometer, Figure 24, is a successful product along this line. The disc at the bottom of the figure contains a pair of tubes which revolve with the shaft whose speed is sought. These tubes form a sort of crude blower by which a partial vacuum is created, increasing as the speed increases and vice versa. The vacuum is transmitted to and recorded by a gage graduated to read in revolutions per minute. As would be expected from the nature of the contrivance the chart scale is an increasing one.

The Crosby recording counter (not a tachometer) is represented by Figure 25. This device is applicable to the measurement of any rotative speed, high or low; but it must be timed the same as the ordinary registering revolution counter. The chart is revolved by the motion of the shaft to be measured by means of a mechanical connection to the lever shown in the figure. One thousand reciprocations or revolutions of this lever produce a complete revolution of the chart and cause one coil of a spiral curve to be described by the pen. The pen moves towards the center of the chart as the chart revolves, so that the total number and fraction of chart revolutions thus recorded indicate the total engine or shaft revolutions.

We have now considered all the usual classes of power plant recorders necessary to the obtaining of complete data (barring some of lesser importance, such as smoke recorders, and others in very common use, such as steam engine indicators). In conclusion, it may be well to repeat the fact that hardly any one of these different recorders is essential in itself and whose service cannot be duplicated by some other one. Thus, the power plant owner or manager has a wide field for the selection of a complete and efficient equipment.

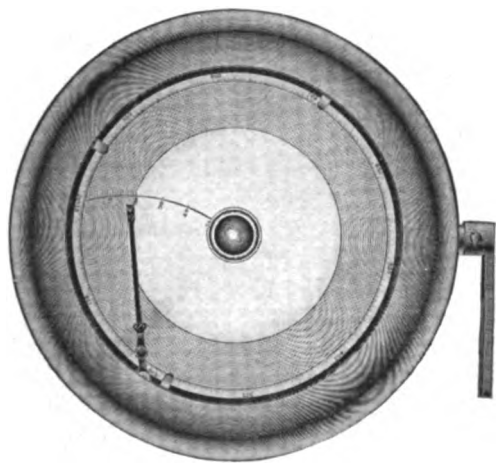

FIG. 25. CROSBY RECORDING COUNTER

To be concluded

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REDUCING COSTS WITH MECHANICAL STOKERS

By Clarence Coapes Brinley

Mr. Brinley shows conclusively how the automatic stoker is effective in reducing costs in labor and fuel, and how easily it can be operated to handle fluctuating loads. He then describes in detail the three general types of mechanical stokers—chain grate, over-feed, and under-feed—and illustrates each type with examples of leading makes.—THE EDITORS.

THE advantages over hand firing to be gained by the use of mechanical stokers are: first, a saving of labor (except in small plants); second, a saving of 15 to 20 per cent in the fuel bill; third, an increase of boiler capacity; fourth, perfect, or smokeless, combustion through complete consumption of the volatile gases; fifth, complete combustion through complete consumption of the fixed carbon; sixth, flexibility, or the ability to pick up or drop a load on short notice.

In plants of 1000 to 2000 horsepower or under a saving in labor cannot be shown as a result of the use of mechanical stokers, and in larger plants the saving that can be effected depends largely upon the use of mechanical equipment for delivering the fuel to the stoker magazines. The coal, it is true, is fed to the furnace automatically by the stoker, but if it first has to be fed to the stoker hopper by hand there can be little or no saving of labor. For hand-firing a man cannot be expected to handle more than a ton of coal per hour with any degree of efficiency. For this reason hand-firing requires one fireman for about every 600 or 700 horsepower. When mechanical stokers are used in conjunction with mechanical handling equipment one operator can handle from 5000 to 6000 horsepower. It has been argued that mechanical stokers require a higher degree of intelligence on the part of the operating crew than do hand-fired furnaces; but even to approximate the results obtained by machine handling, a hand-fired furnace would require an operation with more intelligence than would be needed to operate the most complicated mechanical stoker.

The burning of low-grade coals with an efficiency as high as or higher than that obtained from better grades in hand-fired furnaces has always been one of the chief assets of the mechanical stoker. This is made possible by the regular and continuous feeding of the coal into the furnace, and the constant and even air supply which is the result of minimizing the necessity of opening the furnace door. But the best results from burning low-grade coals are obtained with those stokers which employ forced draft.

The saving effected by operating boilers at from 150 to 200 per cent of rating can be readily appreciated. With the use of mechanical stokers, boiler capacities may be increased to 400 per cent of rating for short periods and can be regularly operated at from 150 to 200 per cent of rating without an increase in the grate surface. The capacity of any boiler is limited by the amount of coal that may be burned in its furnace and by

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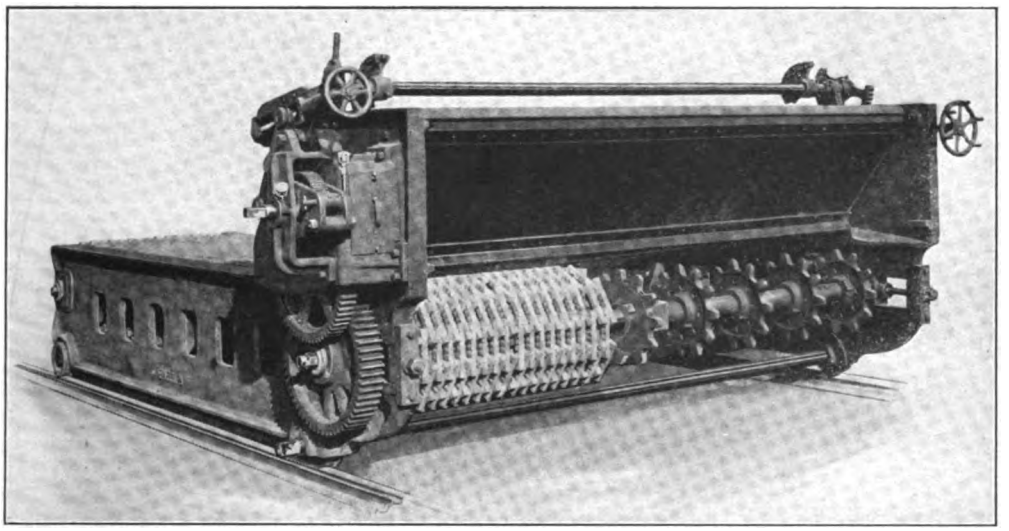

FIG. 1. MECHANICAL CONSTRUCTION OF THE PLAYFORD CHAIN GRATE STOKER
Coal is fed gradually and regularly into the front edge of the furnace, is entirely consumed in its passage, and the ash is dumped over the end

the efficiency with which this coal is consumed. It is obvious that, with the methods employed, a greater amount of coal can be burned over the same grate area, in a mechanical stoker, and at a higher efficiency, than is possible in a hand-fired furnace. But an increase in boiler capacity is economical only within certain limits. Increased capacity means increased maintenance costs, and where fire brick arches are used it is not considered good practice to operate above 150 per cent of rating, but where under-feed stokers are used the boilers may be run economically at 200 per cent of rating. If boilers can be operated at such rating by mechanical stokers, then it requires, for a given capacity, only half as many boilers as would be needed with hand-fired furnaces. It can readily be seen that the saving in space and boiler equipment will greatly overbalance the cost of stoker installations.

Perfect combustion means smokeless combustion. A smoky chimney is not only a nuisance to the neighborhood; it represents a lack of economy. Proportionally there are as many heat units in the volatile matter as in the fixed, and smoke is nothing more than free carbon escaping unconsumed. It therefore represents a definite loss. Bituminous coals contain anywhere from 15 to 45 per cent of volatile matter, and this is thrown off in the form of hydrocarbon gases, or smoke, as soon as the coal is subjected to sufficient heat to cause coking. To insure smokeless combustion these gases must either be passed through the incandescent fuel bed, or be mixed with a sufficient amount of heated air and kept at a high temperature until the free carbon has been completely consumed before they are allowed to come into contact with the heat-absorbing portions of the boiler. A mere excess of air introduced above the fire will not insure smokeless combustion; the air should first be heated well above the ignition point and then introduced at the point where the coking action takes place.

Complete combustion is made possible by any well designed mechanical stoker. This is effected either by

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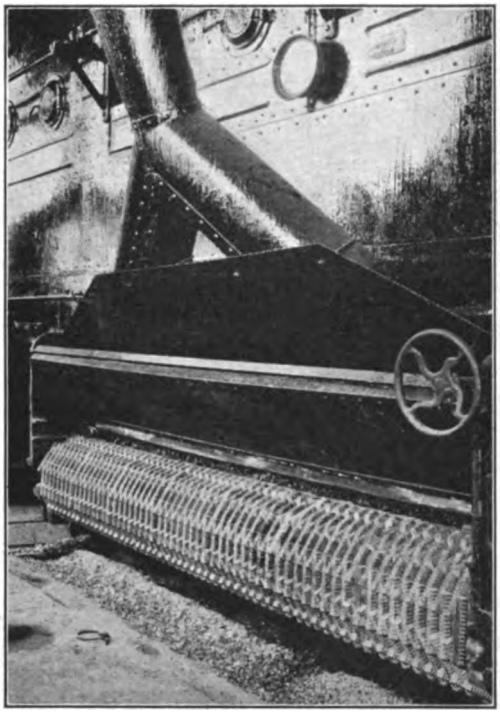

FIG. 2. INSTALLATION OF A PLAYFORD STOKER

feeding the green coal in, alongside, or under the incandescent fuel, instead of placing it on top, as in the hand-fired furnace. Thus the free passage of air through the incandescent fuel bed is insured and the fixed carbon may be completely consumed. Complete combustion, however, is not always desirable, as some coals form an excessively hard clinker when the fixed carbon is entirely consumed.

Fluctuation of the loads, such as occur in electric railway and lighting plants, have demanded a large degree of flexibility in the boiler room. It is evident that, with the mechanical control of the fuel and air supplies, and the ease with which agitation of the fuel bed may be varied, a mechanical stoker can pick up a load much more quickly than a hand-fired furnace and drop it as readily. Naturally those stokers employing forced draft are more responsive than those using natural draft, and many of the forced draft machines are regulated by automatic valves which are controlled by the steam pressure in the boiler.

All of the above mentioned results can be obtained in variable degree with most of the mechanical stokers on the market at present. But the question is not so much what individual make of stoker as which of the three types will give the best results. Before proceeding to a discussion of this point it will be well to familiarize ourselves with the details of the different types and makes of mechanical stokers on the market today.

There are two so-called scientific methods of burning coal in furnaces, and these are responsible for the development of three distinct types of mechanical stokers—the chain grate, the over-feed, and the under-feed.

The first method, progressive combustion, requires that the green coal be fed gradually and regularly into the edge of the fuel bed at the front of the furnace. Here the coal is coked and the volatile gases are distilled. These gases, mixed with the proper amount of air, move across the incandescent fuel bed and are consumed before leaving the combustion chamber. The coked coal is then advanced to finish its combustion and forms an incandescent bed to consume the gases from the fresh coal which has taken its place. This progressive movement is continued while the fixed carbon is being consumed and the ashes are being deposited at the rear of the grate. This method is employed in both the chain-grate and over-feed types of stokers.

The second method, under-feed combustion, requires that the green coal be forced on to the grates underneath the incandescent fuel. Here the coking process takes place and the volatile gases pass up through the incandescent fuel and are consumed be-

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fore leaving the fire. The coked coal is then forced up by fresh coal entering from below, completes its combustion, and forms an incandescent fire to consume the gases from the coal. This method is employed by the various types of under-feed stokers.

The chain grate type is represented by the Playford, Babcock and Wilcox, Illinois, Laclede-Christy, and others. It consists of an endless flexible grate traveling horizontally between two sets of sprockets or wheels. The grate is supported between the pits. On the return run the grate has an opportunity to cool off, before again coming into contact with the fuel bed. Only about 30 per cent of the grate is exposed to the incandescent fuel at any one time. The entire grate surface should be, and usually is, covered by a fire brick arch forming a combustion chamber to contain the volatile gases, causing them to pass over the full length of the incandescent fuel bed before coming into contact with the heat-absorbing surfaces of the boiler. In principle

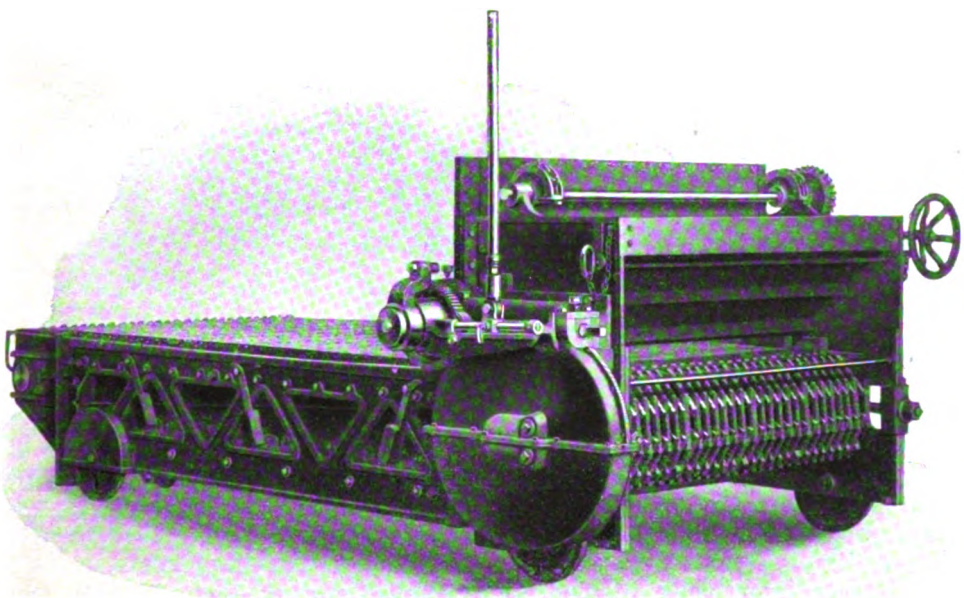

FIG. 3. BABCOCK & WILCOX CHAIN GRATE STOKER
Overlapping flanges at the side prevent air leakage

sprockets on rolls which extend between the side frames, and the whole is supported on a frame which forms a complete unit mounted on flanged wheels and may be entirely removed from the boiler setting to be repaired. Figures 1 and 2 show a Playford chain grate unit. Coal is fed into a hopper at the boiler front and is carried by the moving grate through the various stages of combustion. The ashes are discharged over the end into the ash of operation and general design there is little or no difference between the various makes; the differences are principally a matter of detail.

The principal features of the Playford stoker are: a water-cooled regulating gate at the hopper mouth; a removable water-cooled back at the bridge wall, in place of the regular brick lined gate, which may be lowered to withhold the fuel bed until entirely consumed, or be raised to

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permit the discharge of clinkers; and a flat ignition arch in which the bricks are hung from steel shapes.

The Babcock and Wilcox stoker, Figure 3, also features a water-cooled back at the bridge wall, but no provision is made for adjusting it. Overlapping flanges fitted to the side frames of the stoker and the side walls of the boiler setting to prevent a leakage of air along the sides of the fire are another feature of this stoker.

In the Illinois stoker, Figure 4, the chain passes over rolls instead of sprockets on the rear shaft. The links of this stoker have diagonal air grooves on the sides instead of the usual vertical groove. The links are placed so that the grooves in adjacent links cross each other. This detail reduces the quantity and size of the siftings. Another feature of this stoker is a baffle plate which is placed near the rear shaft between the upper and lower runs of the grate to prevent an excess of air from entering the combustion chamber through the thin ash bed at the end or between the grate and bridge wall.

The Laclede-Christy stoker, Figure 5, differs from the others chiefly in that the grate slopes down toward the back. This is claimed to reduce the amount of power consumed in operation, but it also causes the green fuel to ignite more quickly. This stoker also has rolls on the rear shaft, a baffle plate between the upper and lower runs of the grate, and a flat ignition arch.

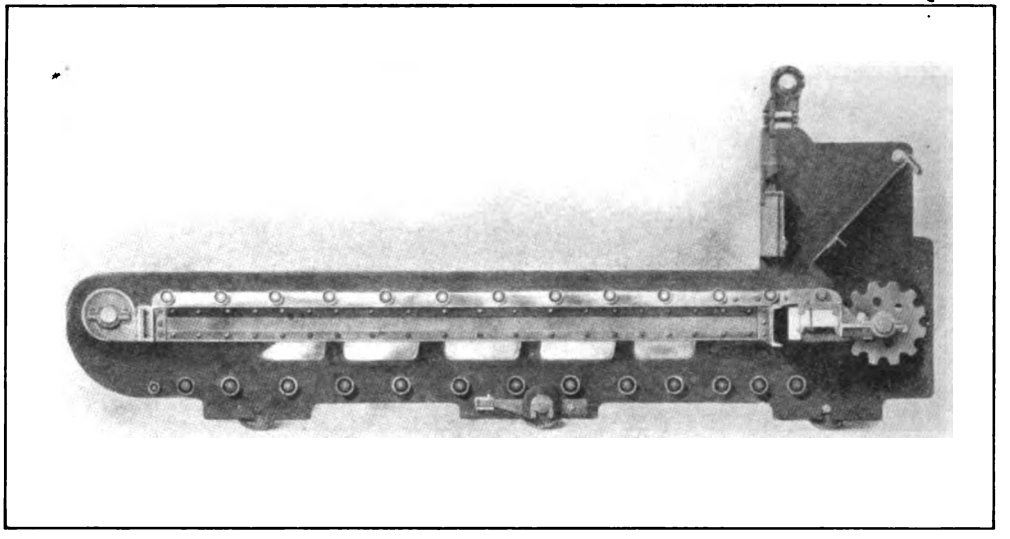

FIG. 4. A TWELVE BY TWELVE-FOOT ILLINOIS CHAIN-GRATE STOKER
On this stoker the chain passes over rolls instead of sprockets

Two other stokers which, because they use a travelling grate, must be grouped with the chain-grate type, are the No-Smoke and the Keystone. They differ in many details, however, from the typical chain-grate stoker. In the No-Smoke the grate is composed of fingered bars about three feet in length running crosswise of the fire box and fastened to strands of chain which travel horizontally between sprockets on the head and foot shafts. The chains are spaced about three feet centers and, being fastened to the underside of the grate bar, do not come into contact with the fuel bed. The fingers of adjacent bars interlock when in a horizontal position

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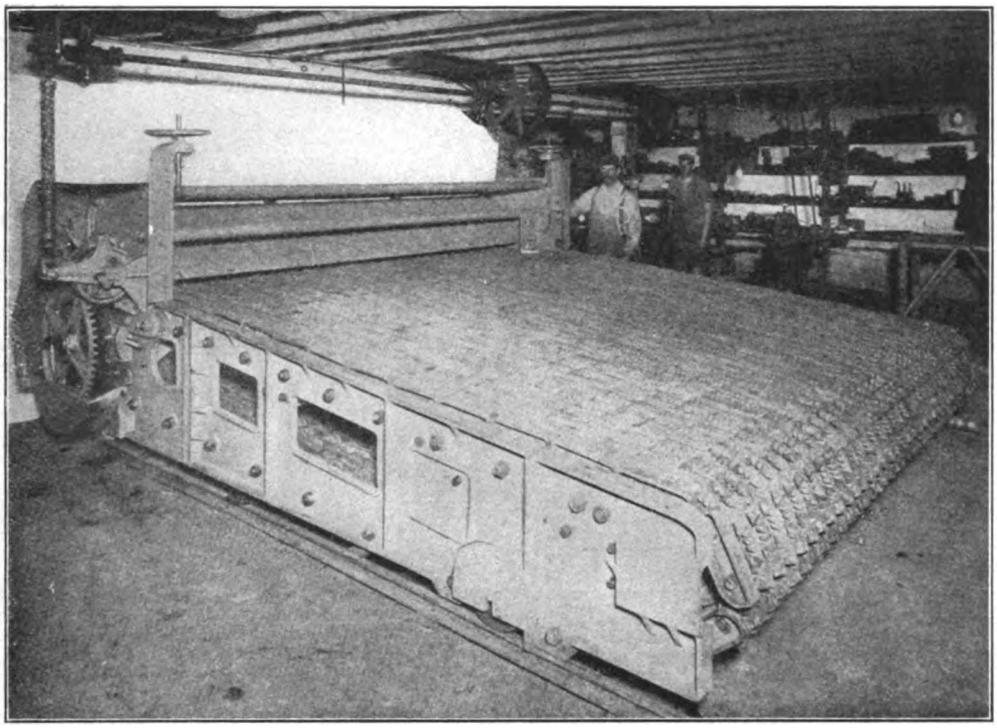

FIG. 5. THE LACLEDE-CHRISTY CHAIN-GRATE STOKER
A slope from front to rear reduces power consumption and causes green fuel to ignite more rapidly

and present a grate surface with a large number of very small openings. On the turns the fingers separate, and automatically clean themselves. But this detail makes it undesirable to dump the ashes over the end of the grate, which is the usual method employed in chain-grate stokers, and a clever substitution has been arranged. An inclined plate is fastened to a secondary bridge wall as shown in Figure 6 and extends over the grate to a

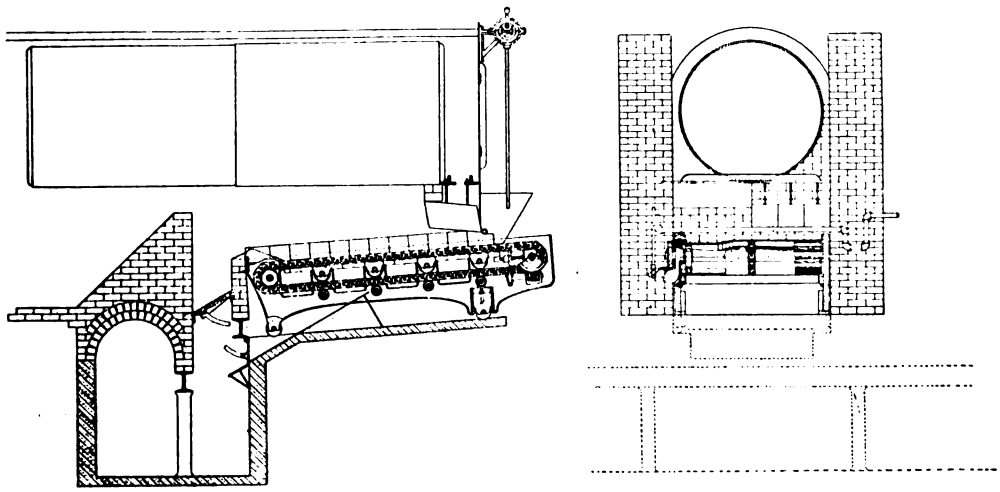

FIG. 6. APPLICATION OF THE NO-SMOKE STOKER TO A RETURN TUBULAR BOILER
Fingered bars are employed, in place of chains, to carry the fuel across the fire bed

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point well in advance of the point where the grates begin to turn. The ashes are forced up this plate and dumped over the secondary wall upon a dumping plate which is operated from the front of the boiler. Provision is also made for agitating the fuel bed by raising the individual bars at different points in the travel.

The grate bar of the Keystone is made up of a series of circular discs mounted on square shafts which rotate as they move through the furnace. This rotation of the grate surface not only saves the discs from burning out but also serves to agitate the fuel bed. The shafts carrying the discs are fastened at the ends, in wide settings also, at the center, to horizontal chains, as shown in Figure 7. The end of each shaft is fitted with a pinion which engages with a rack along the travel of the grate and causes the discs to rotate. Thus, with the grate revolving and the individual bars rotating, any given portion of the grate surface comes into contact with the fuel bed less than 25 per cent of the time. The chains are in the same plane as the grate bars and are protected from the fuel bed by an umbrella-shaped cap, which may be easily replaced, fastened over each link. The links are made with flat bottoms which enables them to ride evenly over the supporting rollers.

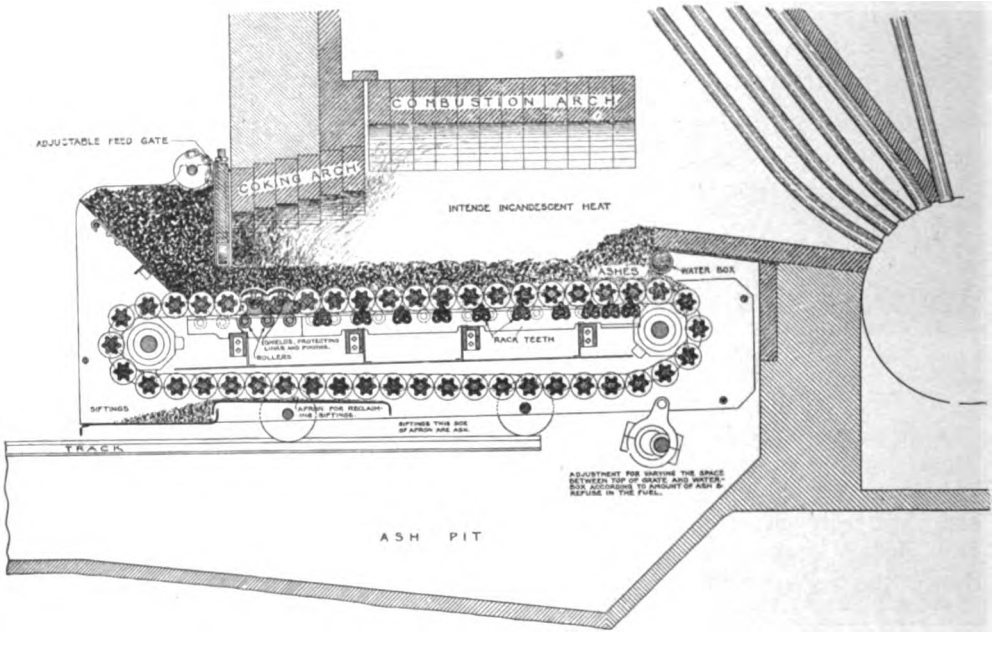

FIG. 7. SECTIONAL VIEW OF THE KEYSTONE STOKER
In place of chains, circular discs are used to carry the fuel. The rotation of these discs prevents burned-out grates and also serves to agitate the fuel

An adjustable apron is placed under the lower run, as shown in the illustration, and causes the returning bars to carry the unconsumed sifting to the front of the furnace. Provision for regulating the discharge opening is made by a set of eccentrics which raise or lower the back of the stoker.

While the over-feed stokers employ the same method of combustion as the chain-grates, the principle of operation is entirely different. There

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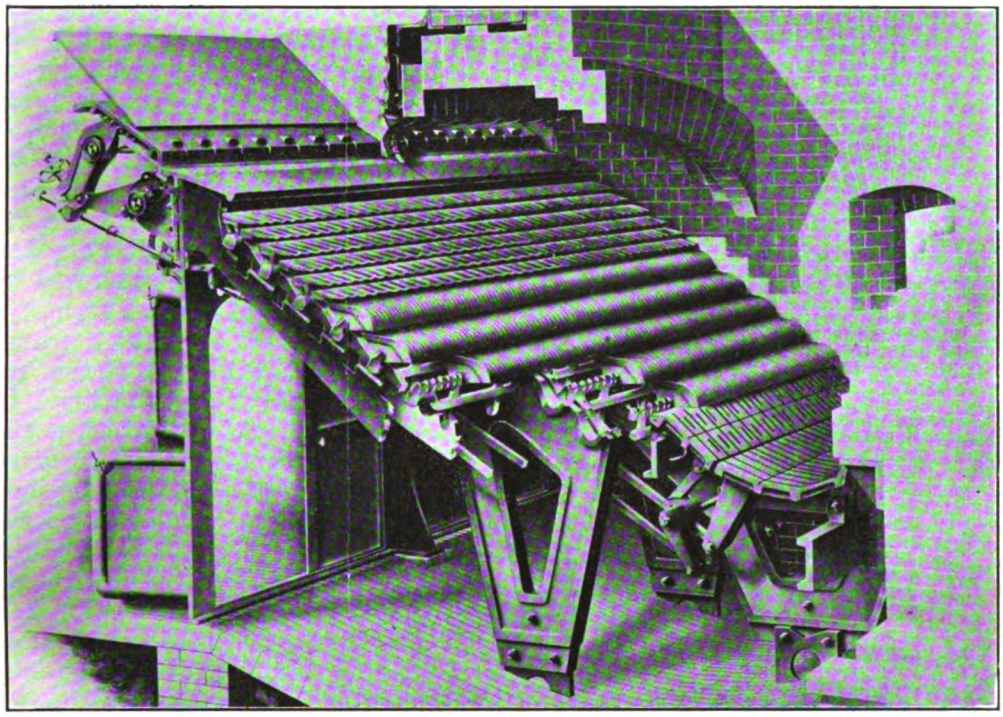

FIG. 8. SECTIONAL VIEW OF THE RONEY FRONT-FEED STOKER

are two distinct types of over-feed stokers: the front-feed type, of which the Roney and Wilkinson are typical examples, and the side or opposed-feed type, which is represented by the Murphy and Detroit. Figure 8 is a sectional view, in perspective, of the Roney. This stoker consists of a series of horizontal bars, with projecting fingers which form the grate surface, running cross-wise of the furnace and sloping at an angle of about thirty degrees from the receiving hopper toward the bridge wall. Coal is delivered to the hopper at the boiler front and is fed to the grates by a reciprocating pusher plate at the mouth of the hopper. For a normal feed this pusher makes about ten strokes per minute. The grate bars are rocked through an angle of thirty degrees by a rod connected to the mechanism which actuates the pusher plate. The movement of the various parts can be regulated to obtain different rates of combustion. The rocking of the bars passes the fuel from one grate to the next and finally to the dumping plates at the foot of the incline. The ashes are not discharged automatically in this stoker, the dumping plates being operated by handles which extend to the front of the furnace. Figure 9 shows the detail at the feeding end of this

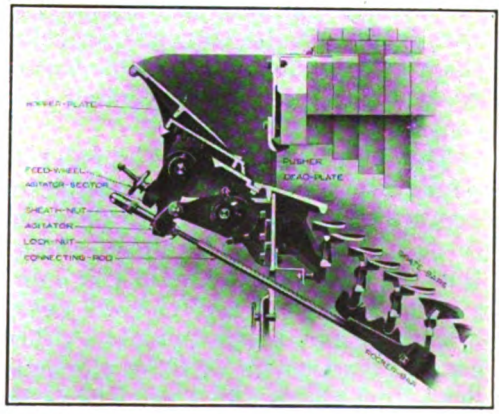

FIG. 9. DETAIL OF FEEDING END OF THE RONEY STOKER

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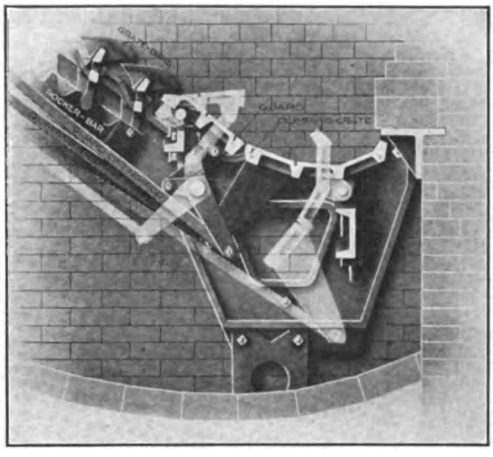

FIG. 10. DETAIL OF DUMPING-END OF THE RONEY STOKER

stoker and Figure 10 the dumping end.

The coking action in this type of stoker takes place on the dead plates adjacent to the hopper mouth. A fire brick arch is sprung over the front portion of the grate where the coking takes place, and is stepped down at about the same angle as the grates. Heated air is introduced into the coking zone through grooves between the inside hopper plate and the first course of the arch. This provides the medium for consuming the volatile matter. A steam jet is sometimes also introduced at this point in these stokers. This type, like the chain-grate, has the advantage of having the volatile gases distilled at the front of the furnace, causing them to pass over the entire incandescent fuel bed before coming into contact with the boiler.

The Wilkinson stoker, Figure 11, is similar to the Roney in principle of operation, although largely different in detail; the main differences being that the grate bars run in the opposite direction and are inclined, every alternate bar being movable. The constant movement of these alternate bars first above and then below the surface of the stationary ones provides a constant agitation of the fuel bed, and causes the fuel to flow down the inclined grates to the dumping plates. The grate bars of this stoker are hollow, and air forced into their ends by a steam jet is delivered through slots at intervals in the upper surface into the fuel bed. The dumping plates are also operated by a handle from the furnace front.

Figures 12 and 13 show a transverse section and a cross section respectively of the Murphy stoker. In this type the coal is admitted at the sides. This detail affords a large coking space and permits of a slow rate of feed, but as part of the coking action takes place at the back of the furnace an ignition arch of greater depth is required than for the front-feed stokers. For this reason most of the side feed stokers are installed in Dutch ovens, but where the boiler setting permits a deep arch, they are often set flush with the boiler front.

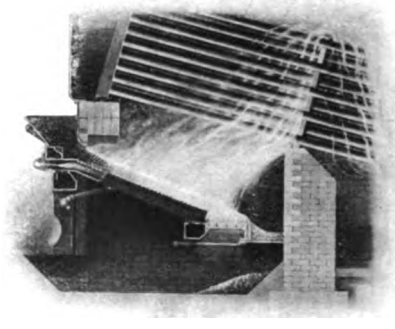

FIG. 11. THE WILKINSON FRONT-FEED STOKER

When this is done the coal has to be forced into the ends of the magazines, instead of being fed by gravity, into the top.

There are no essential differences in operation and only slight differences in details between the various makes of side-feed stokers. Coal is fed into magazines running the full depth of the furnace, on both sides; a

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reciprocating pusher plate forces it out upon the inclined grates, and gravity together with the movement of the grate bars carries it through the successive stages of combustion. The ashes are removed by revolving clinker grinders at the foot of the inclined grates. The grate bars extend from the dead plates at the hopper mouth to the frame supporting the

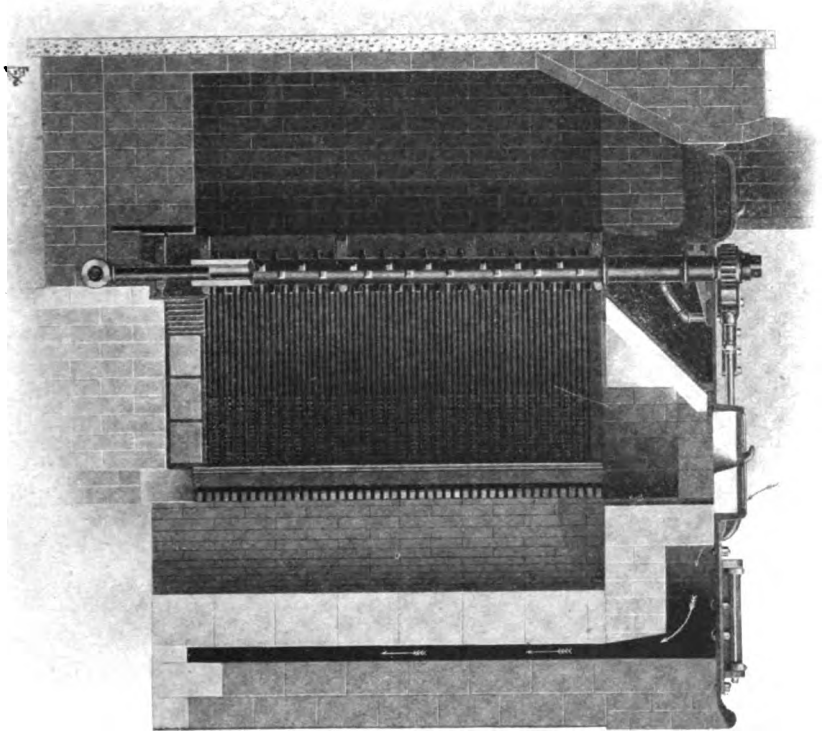

FIG. 12. TRANSVERSE SECTION OF THE MURPHY SIDE-FEED STOKER

clinker grinder, and are made in pairs, one movable and one stationary. The movable bars, pivoted at their upper ends, are moved, by a rocker bar at their lower ends, alternately above and below the surface of the stationary bars. The upper portion of the bars are ribbed to prevent the admission of an unnecessary amount of air through the uncoked coal. These ribs serve also to carry the fine coal before it has coked and prevent excessive sifting. Air admitted to the ducts under the coking plates serves to cool this portion of the furnace. From here it passes to the air space between the arches where its temperature is raised to the ignition point. It is then delivered to the furnace above the coking plates to mingle with the volatile gases and to aid in their consumption.

The under-feed stokers are represented by the Taylor, Riley, Jones, American, and Kokomo. Figure 15 shows the method of operation employed in the Taylor. Coal delivered

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to a hopper at the boiler front is fed into the retort from which two cylindrical rams, assisted by gravity, introduce it into the fire at an angle to the fuel bed. The upper ram pushes the green coal into the coking zone. The action of the lower ram is similar, but instead of bringing in fresh coal it pushes the fuel bed and refuse toward the dumping plates at the rear. The dumping plates are operated by a handle at the furnace front.

The retort or fuel magazine is formed between two tuyere boxes; that is, the tuyere boxes and retorts alternate, the number depending on the size of the furnace. A series of tuyere blocks is supported on each tuyere box, with openings in the vertical faces to distribute air to the fuel. A forced draft system is used to supply air to the fuel bed through the tuyere boxes. With the exception of the dumping plates there are no moving parts in the furnace.

The volatile gases are distilled as the green coal reaches the grates, and, mixed with the incoming air, they are consumed while passing up through the incandescent fuel bed.

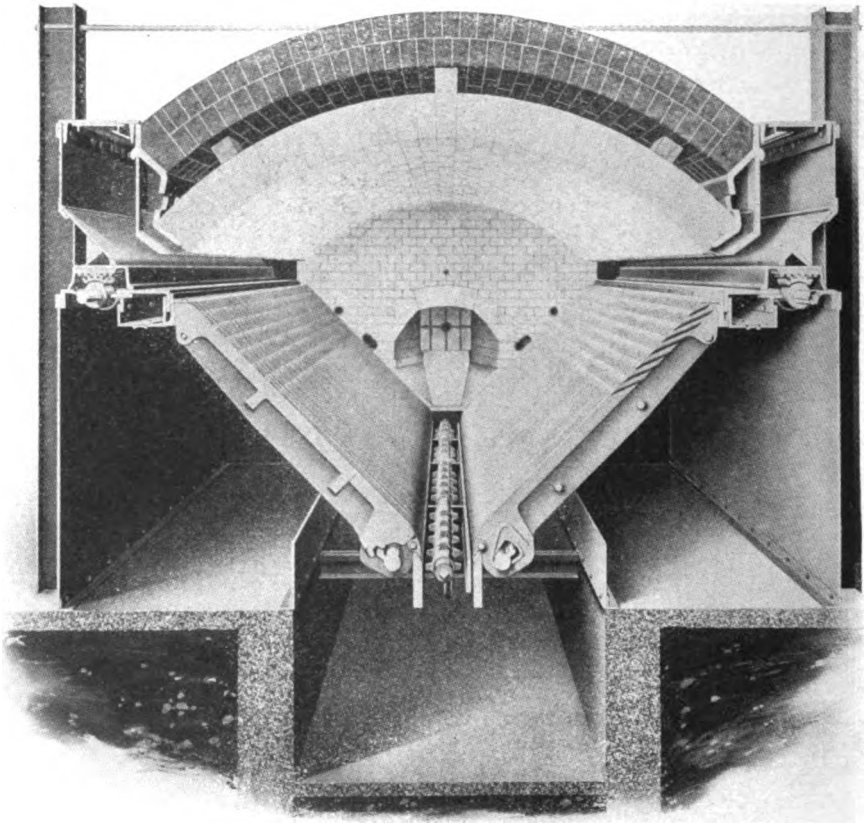

FIG. 13. CROSS SECTION OF THE MURPHY SIDE-FEED STOKER

The Riley is somewhat similar to the Taylor, but in this stoker the tuyere boxes are given a reciprocating motion and keep the fuel bed constantly broken up. Thus only one feeding ram is required for each

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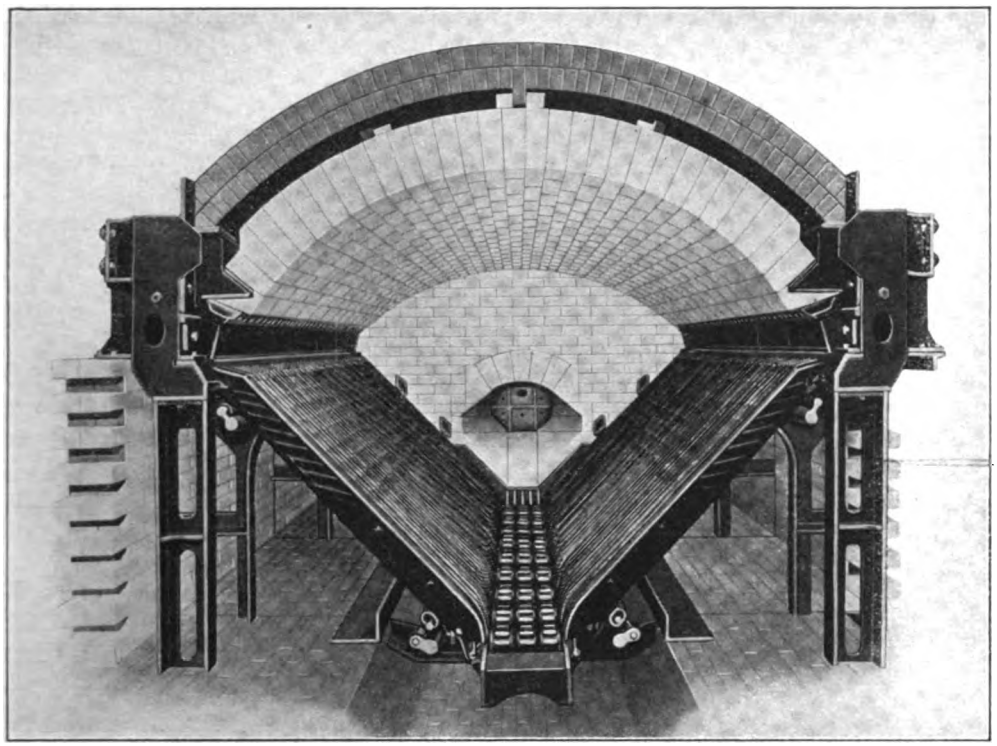

FIG. 14. CROSS SECTION OF THE DETROIT SIDE-FEED STOKER

retort. Figure 16 is a perspective view of a Riley stoker unit. In this stoker a short section of over-feed grates are placed between the retorts and the dumping plates to insure complete burning of the fixed carbon. These grates move with the tuyere boxes above and have vertical faces at the end, toward the bridge wall, which serve as pushers to force the refuse over an adjustable dumping plate. Thus the ashes are automatically and evenly discharged. As in all under-feed stokers a forced draft system is employed.

The American, Jones, and Kokomo are single retort stokers and are well adapted to small boilers. When used in large settings two or more stokers are set in the same fire box. Figures 17 and 18 show the details of the American Type "E" under-feed stoker, which is manufactured by the Combustion Engineering Corporation. Coal is fed into the retort from the hopper by a feeder block which is shown in the longitudinal section. The bottom plate of the retort acts as a reciprocating feeder, to which auxiliary pushers are fastened to force

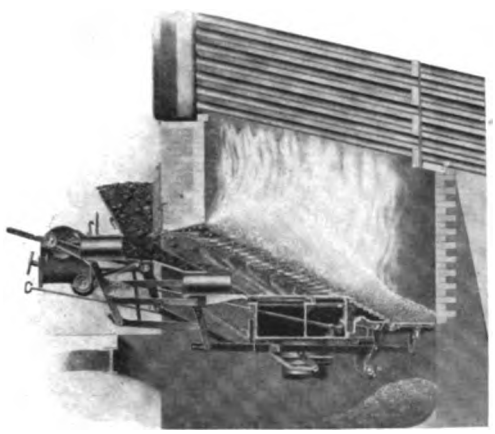

FIG. 15. TAYLOR UNDER-FEED STOKER

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the fuel up and on to the grates. The grate bars slope away from either side of the retort and are set in pairs; alternate pairs are rocked, and the intermediate ones are stationary. Dumping plates are placed at the foot of the grates on either side of the furnace next to the side walls, and are operated by levers from the furnace front. Figure 19 is a perspective view of a Type "E" stoker unit. Air is supplied to the wind box from a fan or volume blower as in other under-feed stokers. The arrows in Figures 17 and 18 show clearly the path of the air; after entering the wind box it passes upward along each side of the retort and is discharged, part through the tuyere openings along the edge of the retort, and the remainder through the hollow fire bars, which are of box-like cross section, and thence into the auxiliary air boxes. From these chambers the air enters the fire through narrow openings between the grate bars.

Figure 20 shows a section through the Jones' stoker. Coal is forced into a retort at the center of the furnace by a steam-driven ram. The retort is shaped so as to distribute the coal evenly to the dead plates on either side. Air enters through tuyere blocks placed along the sides of the retort. Ashes are removed by hand from the top of the fire through what would ordinarily be the fire door.

The Kokomo under-feed stoker is somewhat similar to the American, having inclined rocking grates and clinker grinders which insure a self-cleaning, active, fuel bed.

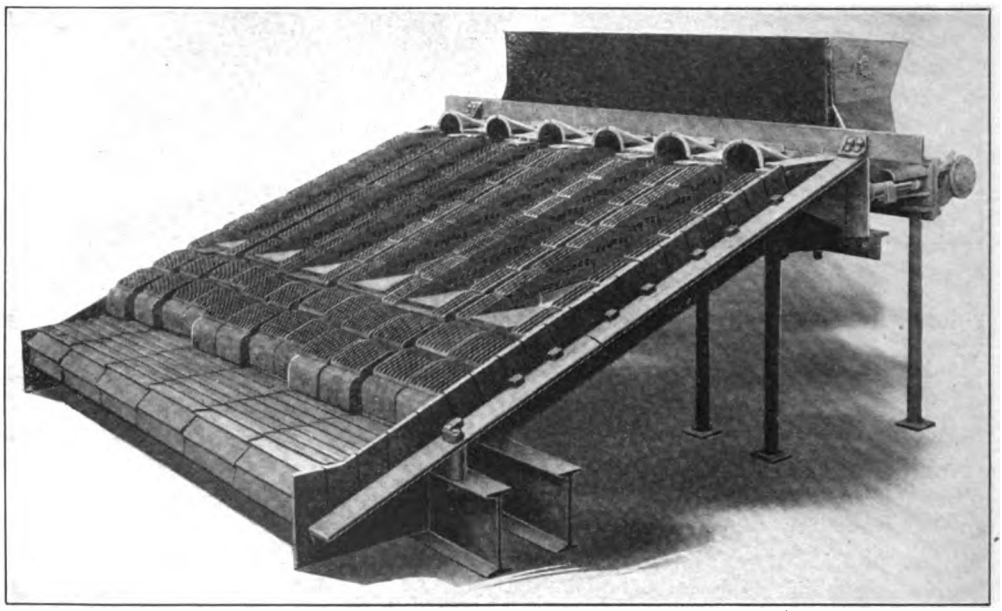

FIG. 16. PERSPECTIVE VIEW OF THE SANFORD-RILEY UNDER-FEED STOKER
Green coal is forced upon the grates beneath the burning fuel and in turn is forced upward until totally consumed

The Westinghouse Electric & Manufacturing Co., makers of the Roney stoker, build also an under-feed stoker which is similar to the Taylor, with the addition of an automatic dumping device; but this stoker has not as yet been featured by its builders and the installations have been largely experimental.

From the viewpoint of labor sav-

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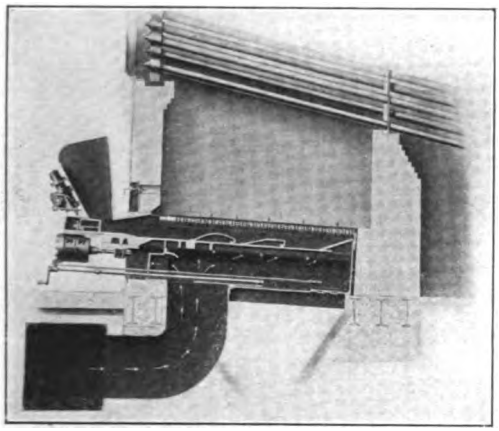

FIG. 17. AMERICAN UNDER-FEED STOKER, TYPE "E." LONGITUDINAL SECTION

ing, the chain grates and the under-feeds, such as the Riley, which automatically dispose of the ashes, hold first place. The over-feed stokers require more attention because hand slicing of the fuel bed has to be resorted to frequently to break up the clinker. This is also true of the under-feeds which use dead grates. With chain-grates, or self-cleaning under-feeds, one operator can take care of about ten furnaces, if the fuel is delivered to the stoker hoppers mechanically. With the side-feed type one man is required to about every six furnaces; while with the front-feed types one man is required to about every four furnaces, mainly because the dumping plates are operated by hand. Of course, the under-feed type in which the ashes have to be removed by hand has little value as a labor-saving machine.

Any one of these types will burn a poor grade of coal economically, but the chain grates are restricted to high ash coal such as those mined in Illinois and Ohio. For this reason this type is found most generally in the Middle West. Low ash coals leave a thin fuel bed over the rear portion of the grate, and the ease with which the air passes through it causes it to burn freely. The result is a hot fire directly next to the grate, which is apt to cause warping and breaking the links. Over-feed grates are affected somewhat in the same manner. Where low ash coals are to be burned at high rates of driving, under-feed stokers will give the best results.

It stands to reason that more coal can be burned over a given grate area with forced draft than with natural draft; and since the capacity of a boiler depends largely upon the amount of coal that can be burned in its furnace, it follows that those stokers employing forced draft will give the best results when increased boiler capacity is desired. As neither the over-feeds nor chain grates can be economically operated at extremely high ratings with forced draft, on account of the attendent increase of maintenance costs, the under-feeds alone are satisfactory for this service. Ordinarily it is not good practice to operate at extremely high ratings, however, on account of the wear and tear on the boiler parts as well as on the furnace setting. But an

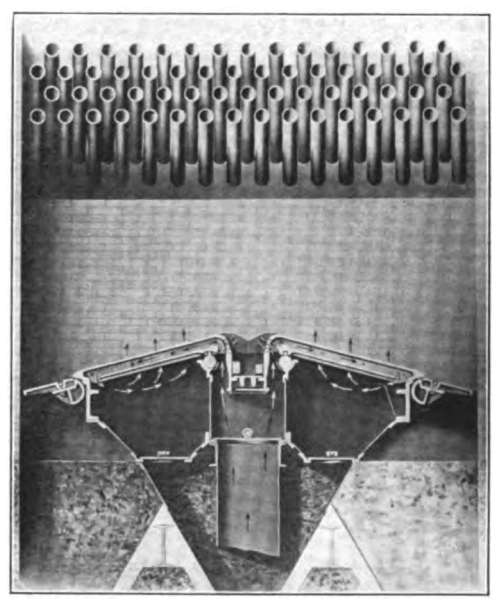

FIG. 18. AMERICAN STOKER. CROSS SECTION

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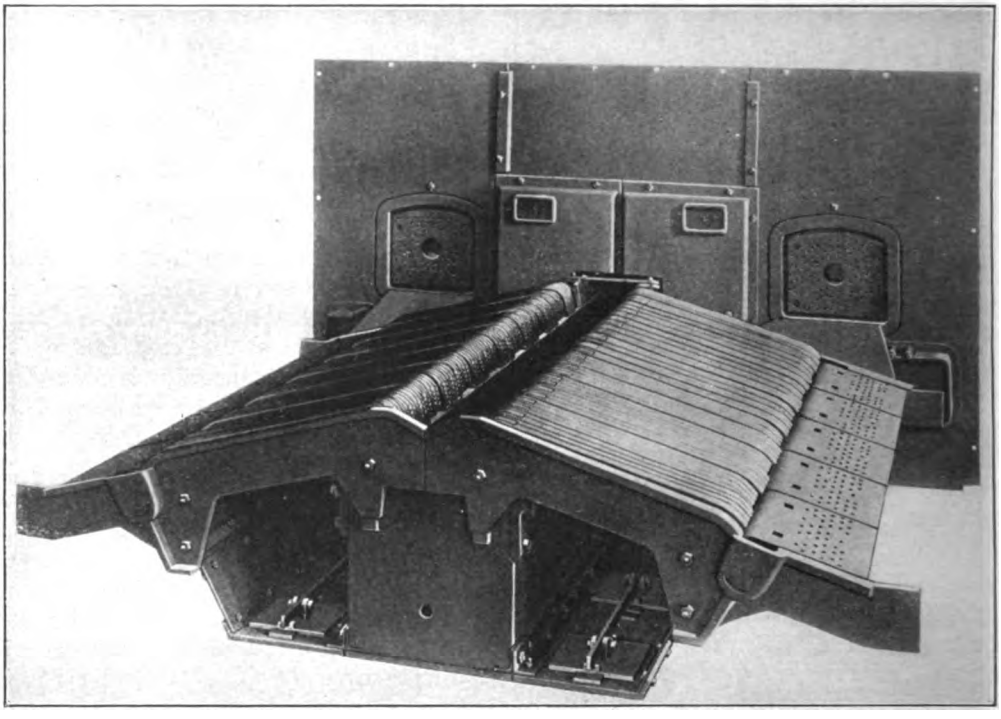

FIG. 19. THE AMERICAN TYPE "E" UNDER-FEED STOKER
Coal is fed into a retort, shown in Figure 17, the bottom of which acts as a reciprocating feeder and forces the coal upon the grates

under-feed stoker can be operated more economically at such ratings than either of the other types, for the reason that it requires no fire brick arches, which are more costly and troublesome than any other part of the setting. With under-feed stokers, boilers may be operated for short periods at 400 per cent of rating with a combustion, per square foot of grate, of about 85 pounds of coal per hour; or they may be operated continuously at 300 per cent of rating with a combustion, per square foot, of about 60 pounds of coal per hour.

The maximum boiler capacity obtainable with the slope-grate over-feed stokers is about 200 per cent of rating, burning about 40 pounds of coal per square foot of grate per hour with natural draft. The maximum capacity obtainable with chain-grates is about 260 per cent of rating with a combustion of about 50 pounds per square foot, but this entails a substantial increase in the grate area. However, very few plants consider it good practice at the present time to operate continuously above 200 per cent of rated boiler capacity.

It appears to be the consensus of responsible opinion that under-feed combustion is the only sure smoke preventive. In under-feed stokers, such as the Riley and Taylor, the coking action takes place over almost the whole grate area and the gases have to pass through an incandescent fuel bed at least two feet thick. This makes it impossible for any of the volatile matter to escape unconsumed, except when holes occur in the fire. Over-feed stokers, when properly installed and carefully manipulated, will effect practically smokeless combustion. Of this class the side-feed type, on account of its large coking area and the size of its combustion

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chamber, will give the best results. The introduction of pre-heated air above the coking area has aided materially in reducing the smoke in this class of stoker. The chain grates depend entirely upon a large combustion chamber to eliminate the smoke. No provision is made in any of these stokers to introduce hot air above the fire. There is much leakage of air in all chain-grates along the sides, over the end, and through the coal hopper; and any air introduced above the fire would only add to the natural excess of air which is one of the bad features of this type. However, on account of their large combustion chamber and additional grate area these stokers when driven slowly will effect reasonably smokeless combustion.

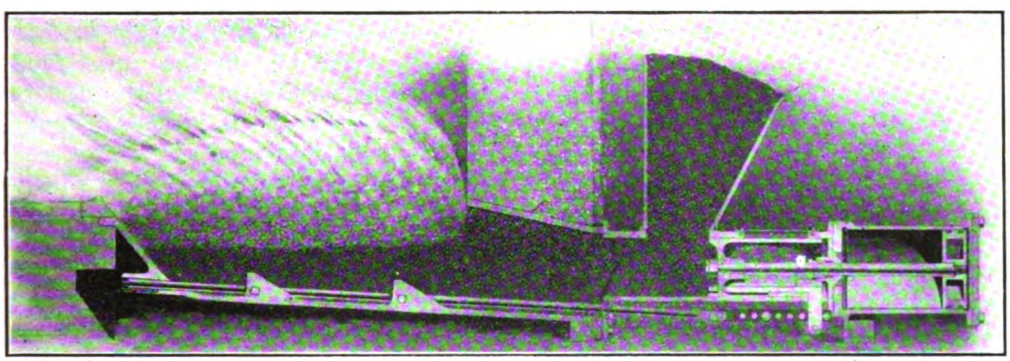

FIG. 20. A SECTION THROUGH THE JONES STOKER
Coal is forced to the center of the furnace by a steam-driven ram

For complete burning of the fixed carbon the chain-grate stoker will give the best results; the fuel simply rests on the grate, undisturbed by the introduction of fresh fuel, and the travel of the grate can be regulated to allow all of the burnable elements to be consumed before the refuse is dumped over the end. The moving of the fuel bed with the grate insures the automatic removal of the large hard clinkers which form when the fixed carbon is entirely consumed. With the over-feed stokers, especially the side-feed type which employ the clinker grinders, considerable difficulty is experienced in removing these large clinkers. Under-feed stokers, in general, do not completely consume the fixed carbon, but the extension over-feed grates, as used in the Riley, have successfully removed this objection. These extension grates are sometimes used with the Taylor but they are seldom actuated. The under-feed stokers which do not employ moving grates very often form excessive clinker on top of the fire which cannot be broken up. The air, which is forced into the furnace, unable to penetrate the fuel bed is returned against the grates, causing a blast lamp effect, and a burning of the iron results.

Because of the use of forced draft, under-feed stokers have a greater degree of flexibility than either of the other types; and, on account of their agitation of the fuel bed, the over-feed type is more flexible than the chain-grate. To pick up a load with an under-feed the coal supply is increased by speeding up the plungers, and the air supply, by speeding up the fan. In most cases both fan and stoker engine are regulated directly by the steam pressure in the boiler. The over-feed stokers can increase the rate of feed and the amount of agitation of the fuel bed to start up the fires. But the chain-grates are limited to an increase in the speed of

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the grates. Fire will not spread as rapidly on the horizontal as it will up hill, especially in the opposite direction to that in which the air supply is traveling. Thus a chain-grate cannot travel any faster than the green coal can be ignited, and, unless the fire brick arch is sloped so as to reflect the heat at the bridge wall over the coking zone, the progress of combustion must necessarily be comparatively slow. It has been claimed that under-feed stokers can pick up a load of 200 per cent of rated boiler capacity from a banked fire in seven minutes. Experienced operators say that the truth of this statement depends upon what you mean by a banked fire; but a load of this size can be picked up, from a fire that has been banked over-night, in about twelve or fifteen minutes.

Other points to be considered in choosing a stoker are: the initial expenditure involved, the cost of operation, and the maintenance charges. The over-feed stokers average roughly about five, chain-grates about six, and under-feed stokers about seven dollars per rated boiler horsepower. For the under-feed type this includes the forced draft system. The operation of the fan and the rams for an under-feed stoker consumes about two and one-half per cent of the steam produced by the boiler. For the over-feed type and the chain-grates less than one per cent of the steam produced is consumed in operating the stoker. It can readily be seen that the maintenance charges will be affected largely by the number of moving parts that come in contact with the incandescent fuel. In the chain-grate we have the maximum number of such parts and in the under-feed stokers the minimum. In the under-feed stokers there is always a layer of green coal between the grates and the incandescent fuel which protects them from the heat of the furnace. Replacing or repairing burned out firebrick arches is the most costly item in furnace maintenance, and these arches are not required with under-feed stokers, the fuel bed being directly beneath the heat absorbing surfaces of the boiler.

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How to Secure Foreign Trade

By Frederic Schreibman

IV. PROJECTED PLAN FOR A LEAGUE OF AMERICAN EXPORTERS

In proposing the formation of a League of American Exporters to conduct selling forces in Europe, Mr. Schreibman does not attempt to indicate what initial steps should be taken in the work of convening and organizing such a group. He realizes that an attempt to lay down rules or formulæ would be folly, and that if a group of manufacturers should agree that his ideas were feasible, they themselves could more adequately solve the initial ways and means. Hence, he assumes herein that the League has been formulated, and contents himself with an analysis of the course they should pursue in making their League successfully effective in Europe.—The Editors.

IT would be advantageous to have a league of manufacturers for the purpose of introducing to the European markets such products as the machines and other apparatus used in mechanical and electrical industries.

Such a league should have the fullest information on the following questions:

1. How must it work to obtain the maximum of result with the least expense of effort, money, and time?
2. What particular products and what quantities of them could be successfully exported?
3. In which country would a given article find the best market?
4. Which manufacturers could make certain products for exportation?
5. What reorganiation would best help any manufacturer in exporting his products?

LEAGUE—GROUPS—PROGRAM

This league would be called the League of American Exporters and would be divided into groups, such as those furnishing the following products:

(1) The equipment of power stations, lighting plants, etc.

(2) Machine tools, equipment for manufacturing establishments, etc.

(3) Steel, foundry work, mine supplies, etc.

(4) Stationery, office supplies, etc.

(5) Breweries, sugar plants, chocolate works, etc.

The present system of selling through agents or local jobbing houses is altogether defective. The result is frequently *nil*, and the exporter is altogether too much *at the mercy of his agent*.

The League would therefore study, by means of its delegates, the needs of each country, the best methods for organizing in each section, the local methods of transacting business, and the best sources of information, with the means of using them.

I have already indicated the reasons for not advising the use of local jobbing houses. I have also shown the advantages of securing eminent persons as directors, and of employing local agents, whose advertising expenses are taken care of by the exporter. These methods are not always possible for a *single exporter*, but are easily realized by a *large group*. This will be the more easily done since the group will have the support of the entire League, and thus of the American government,

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and the banks and consular service in particular.

Let us suppose, then, that the League forms in some European country a series of companies for selling the products of the different groups on a commission basis. The form of sale will be as at present, but the League will control these companies, and the expense will be minimized by being divided among the members.

The manufacturers belonging to the League and having its support will be able to gain the public confidence in their products *far more rapidly* and at *less expense and risk* than if they attempted to export on their own account. The companies already exporting American goods might also find it to their advantage to join the League. It is well known that before the war the Germans had installed themselves in various foreign countries. For obvious reasons they did their best to hide their origin by organizing local companies which they *secretly* controlled. But since the United States is on friendly terms with all the European countries, no such concealment would be necessary, and the companies could *openly* declare themselves as American.

In order to answer intelligently whatever questions will arise, *the fullest information will be necessary.* The selected delegates of the League should study, not only the conditions existing in Europe before the war, but the manner in which the war has modified these conditions, and the systems to be employed after the war is over.

When all the systems have been studied, a choice must be made among them. The best ones will be retained; the others will be modified as may be necessary. Above all, one must not believe that a system is perfect simply because all the rules and formulae have been worked out. Such logic is altogether false, for different countries and different conditions require altogether different methods, and what would be good in one country would be thoroughly bad in another.

Just as the state of health of the human body has its effect on the workings of the mind, the manner of conducting business affects the state of mind of the customer. This is a matter of common experience. Anyone would rather buy from a sympathetic acquaintance than from an antipathetic stranger, even if he must pay more for the same article. In fact, the existence of this sympathy usually makes him feel that the quality of the article is really superior. This is only natural, for we habitually overestimate the qualities of those we like, and underestimate those we dislike, without being conscious of doing so.

The League should therefore do everything necessary to teach European conditions to the manufacturers who have not yet attempted exportation. It should also spread information as to America and its products among those who may become future customers. In doing this, however, care must be taken to adopt such a manner of procedure as will awaken *sympathy* and not *hostility.* The information gathered should be *centralized,* so that all who may need it can use it *quickly, easily,* and *advantageously.*

I deem it necessary to say in what way the League would act when someone comes before it and says, for instance, "I am manufacturing moulding machines, for use in foundries. I should like to know if my article could advantageously be sold abroad, and in case it could, *where* and *how?*" Immediately the League

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will place at the disposal of this manufacturer all the information which it will have collected and which can be of interest to him. For example, it might advise him as follows: "If you are going into France, you will encounter such and such competition. You will find certain foundries of about this grade of importance. The competition which comes from such a country has brought in so many machines during a given period, which have been sold at the following price. Also, there are in such and such localities native manufacturers who are producing moulding machines. The expenses for transportation, duties, publicity, office, etc., would amount to about so much. In order that you, the manufacturer, may be able to sell your machines to advantage in France, it will be necessary for you to produce them for such and such a price delivered at such a port. Can you do it? In case of necessity we can assign one of our experts to your plant who can tell you if you are working in a way to obtain the maximum efficiency and how you can change certain machines or certain methods to obtain the best results.

"Now, if instead of going into France, you select Russia or Turkey, the conditions to be met will be changed in the following respects."

* * * * *

In a word, the League will guide the manufacturer step by step. It will aid him in a manner suited to his character, location, and means. I think it necessary to insist on this word "guide." Everyone recognizes that children must be guided, but when they have once left school, they are allowed to do as they please. Nobody is there to advise or help them. But the only real difference between a child and a man is that the child makes many *small* mistakes, and the man very *important* ones. Moreover the child's mistakes seldom harm anyone but himself; the man may not only injure himself, but many others as well.

The Government intervenes, it is true, by means of the mechanism of the law. But everyone knows how ineffectual this is. The losses already incurred can seldom be made up, and the punishment of the defaulter does not restore the money he has already spent. What is needed is a means of *preventing* these losses, and not of punishing them after they take place.

Let us now consider a project for the organization of an office of the League in a given locality. In this, I shall indicate only the general lines of the organization. As to the *new* means that I propose, I know that many will differ with me, either because I do not explain myself clearly enough, or because, once my article has aroused their interest in the subject, they will themselves find better means for solving their problems. But in any case, everyone will agree that many conditions existing in Europe are capable of improvement. It is, therefore, to the advantage of all manufacturers who know nothing about these conditions to learn them. before attempting to export their goods to Europe.

SCHEME OF ORGANIZATION OF A LOCAL CHAMBER OF COMMERCE IN A EUROPEAN INDUSTRIAL CENTER

DUTIES OF A LOCAL FOREIGN AGENCY OF THE LEAGUE

Let us consider some of the duties of a local agency of the League in an important industrial center. This may be located in any country of Europe. The general considerations are always the same, and although the details of the method of working may vary, it will not be necessary to discuss them now.

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The first and most important consideration is that everything about us must *inspire confidence:* the name, the building, the interior arrangement, the president, directors, associates, etc.

INFORMATION TO BE PROCURED

Each local agency of the League ought to procure:—

1. A list of all the industries in its territory;
2. Information as to the capital, credit, etc., of existing industries;
3. The names of the members of boards of directors of each company, of their various managers (both office and factory), superintendents, buyers, etc., with notes on the imporance and influence of each one;
4. A list of the materials bought by each, the quantities, and current prices;
5. A list of machinery, etc., used by each, with details as to types, sizes, qualities, and origin.
6. Information as to receiving days, etc.

EXPERTS

Each agency should have at its disposal an expert in *each type of industry* that it is trying to introduce. He should be ready at all times, to visit any factory with which there is occasion to deal, in which visit he will usually be accompanied by an information agent.

As *very few* factories are perfect, he will nearly always be able to suggest some improvements of considerable value. Even if this does not lead at once to an order, it will inspire confidence, which will later be of value. Moreover, it is to the advantage of the manufacturer to deal with supply houses who can help him in such ways.

The specialists will report to the agency any improvements they think might be introduced in America, and any *changes in manufacturing methods,* better fitted to the European market. They will go, not as *spies,* but as *collaborators,* aiding both the manufacturers and their employers. The former will, therefore, soon realize that they are dealing with friends.

Generally speaking, these specialists need speak *nothing but English.* This will have a better effect on the workmen and superintendents. They will be more obliging to a stranger from a *friendly* and *respected* country. They will be more ready to follow his advice and to give him information, than to one of their own compatriots.

The managers and directors of the factory will also have the opportunity to "show off" their more or less imperfect English. The specialist should, however, be accompanied by a native, such as the information agent already mentioned, to serve as interpreter.

CATALOGUES

As I have said in an earlier chapter, the example of the German manufacturers is worthy of imitation. The catalogues should be translated into *several foreign languages.* Even if they are only for circulation in one country, it is advantageous to print them, not only in the language of that country, but in two or three others as well.

STANDARDIZATION IN THE MANUFACTURE OF SPECIAL PARTS

A question of considerable importance, which frequently arises, is that of a customer or a possible customer who asks the manufacturer to make some special piece differing appreciably from those currently made. Even though such an order is unprofitable it would be a mistake to refuse it and allow it to go to someone else who would charge it to *advertising.*

This type of advertising is, in fact, the most profitable. It will often gain

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a new customer or hold an old one where newspaper and magazine advertising was of no value. One may often have such pieces made in a small outside shop, but if the customer is likely to be an important one, or the fabrication of the piece is at all difficult, it is advisable to do it one's self, even if one loses on the first order.

STOCKS OF MERCHANDISE

Unless the product is one that is very special and rarely used, the agent must usually have a greater or less stock on hand, so that he can show the client the merits of his product, as compared with those of other manufacturers, and make immediate delivery in case of purchase.

This stock is all the more necessary as the distance from the factory increases, (particularly in the case under discussion, where the factory is in America and the customer in Europe), as the competition increases in intensity, and as the use of the product increases.

There will arise cases when one must keep in stock articles not currently used. In other cases the agent will ask the buyer to take certain goods on consignment, and pay for them as they are used. This happens particularly with large purchasers and articles of general and extensive use.

To keep up the large stock required, it may easily be seen, entails a very heavy expense.

ARBITRATION

As far as possible, all discussions between customers and American manufactures should be settled amicably, even if the manufacturer concedes points where he is sure he is right. If the case goes to law, and the manufacturer wins, he may still be the loser *indirectly*. He not only loses the lawyer's fees and other expenses, and a great amount of time and trouble, but also he will lose a customer who may be of great value, and who, as an enemy, may do infinite damage. And even if he is right, he is not sure of winning. Judges are often prejudiced by many motives, or so ignorant as to be incapable of judging correctly. Their official position is, in no country, a guarantee of their superiority to the average man.

SCHOOL FOR EXPORTERS

The League could begin at once special lecture courses for the use of exporters and their employees, including engineers, department heads, information agents, etc. These lectures might teach:

(a) Miscellaneous knowledge concerning Europe and export business,

(b) Statistics concerning exportation,

(c) Foreign languages,

(d) Foreign business methods,

(e) Systematic methods of working and supervision,

(f) The preparation of catalogues, samples, etc.

Incidentally, it must be remembered that, due to the war, all statistics obtained are more than ever uncertain, and that great future changes may be expected.

It is evident that the ordinary academic system of lectures given by professors, with the usual periodical examinations, is of no value for this purpose. On the contrary, the lectures should be given only by those familiar with *both theory and practice;* nothing should be taught that does not apply *directly* to the desired purpose; the character of the pupils should be studied, from their entrance into the school, with reference to their *fitness* to be department heads, agents, specialists, etc.

ADVERTISING AMERICA TO THE EUROPEANS

At present, the European public has no knowledge whatever of America. Let me cite an instance. Not

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long ago a well-known American told me how he had been sent to Europe on official business, and had met one of the government ministers, who asked him: "What is the official language spoken in the United States?"

If a person of this importance is so ill-informed, judge of the ignorance of the general public. It is true that the European libraries contain books full of information about America, but who takes the trouble to read them?

The general opinion of Europeans concerning America is gained from those Americans who have been in Europe. Since few of these can speak the language of the countries they visit, and can therefore hold no intercourse with the natives, they are only noticed when they come in conflict with local customs and ideas, and thus necessarily produce an unfavorable impression.

I should suggest as a remedy *popular lectures* on American institutions, illustrated by *moving pictures*. These lectures should be adapted to both adults and children, so as to be of the greatest value, and should be made as interesting as possible.

Up to the present, the only American moving pictures shown in Europe are those depicting cowboys, train-robbers, detective plots, and the like. It would be desirable to show the great American manufacturing plants, the universities, the cities, and harbors,—in fact, all the chief phases of American life, especially those of a favorable nature. It is particularly useful to show American manufactures and industries, insisting on the names of the products and their makers.

This insistence on *names* and *trade marks* is of the greatest psychological importance. Suppose for instance that a shoe manufacture wishes to buy a dynamo. If he is offered a make that he has never heard of, he will refuse it, and ask for one that he "knows." If he is persuaded to buy, he will be constantly on the watch for trouble, and will blame the maker for everything that goes wrong.

If, on the other hand, he is offered a make that he "knows," that is to say, of which he has seen the name hundreds of times—and usually his knowledge goes no deeper than this—he will readily make the purchase, and in case of accident he will be less likely to blame the maker in whom he has confidence.

In short, one must do everything to make one's self known and to inspire respect and sympathy. This being accomplished, the rest is comparatively easy.

CLUBS

In forming clubs, they should not be composed exclusively of Americans. It is better to form *mixed* clubs, or to join native clubs already existing.

Whatever one's tastes may be, it is bad policy to isolate one's self from the people of the country. If one draws back from them, they also will draw back, and thus the difficulty of forming relations becomes constantly greater. On the other hand, in a mixed club, one soon establishes friendly relations, and relations thus formed easily become of great business value. The best place to discuss business deals is often at the supper table or in the smoking room.

The Americans who come into contact with the natives should guard against *considering* themselves a superior race, and above all, against *showing* this feeling. One is not superior to another merely because of the country of his birth. Besides, every nation has its own particular qualities which others lack, and these are worthy of respect. Everyone knows this, but few practice it. The Germans, in

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particular, have come to be disliked in many countries, because of the arrogance nd tactlessness of a *few* of their compatriots, and thus a *whole nation* has suffered for the faults of a few of its members.

EMPLOYMENT BUREAU FOR AMERICANS

The local agencies of the League should do everything necessary to secure positions for young Americans in the establishments in their territory, thus enabling them to learn the local business methods. Like the specialists, they can thus be of value both to the League and to the local manufacturers.

The Germans have already used this system very extensively. But if one imitates them in this respect, one must avoid certain errors of which they have been guilty; for example, a young German will accept a position without pay, to the detriment of the young natives of the country; he will worm his way into the secret workings of the business, and when he has learned everything about the business, he will mysteriously find capital with which to compete with his former employers.

If there are Americans in the various departments of any company, it will be easier for the League to deal with that company, both in placing orders and in settling disputes. But such Americans must always act with the tact, fairness, and honesty.

INFORMATION AND SALES AGENTS

Many of those now engaged as retail salesmen could be made into excellent sales agents or information agents, for the use of the League. One need only teach them to work *methodically*, and supervise their work according to best American methods.

INFORMATION AS TO CLIENTS, AGENTS, AND EMPLOYEES

As I have already explained, much of the information received is to be taken as little worthy of belief. One must exercise one's judgment in this matter.

It is not as if one could choose to deal only with the best firms; one has to deal with many small houses, and one has to inform one's self as to their standing. This is often difficult, since they have little or no capital, and the only persons they can give as references are those of their own class, who are similarly situated.

The same is true of employees. In asking them where they have worked before and receiving information from previous employers, one is by no means sure of its value. He may often have been discharged from some position through no fault of his own, either through the incompetence of his superiors or because he was assigned to work for which he was unfitted, and yet he might do very well in the new position for which he applies.

SELECTION OF EMPLOYEES

This question is very important and complex. It deserves a special consideration.

In general, positions are given to those who have "pull" rather than to those who are fitted to fill them. This is obviously unjust; it is also disadvantageous to the employer. The greatest care should be taken to have the right man in the right place. It is not enough to explain to an employee the duties and responsibilities of his position; one must first be sure that he has the *character* and *training* that fit him for the position.

Moreover, if a man is unfit for his task, the more *intelligent* he is the more trouble he can make. His intelligence serves only to hide his ineptitude for his tasks for a longer time, in which he may make mistakes of a most disastrous nature and importance.

For every position one has to fill,

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whether clerical or technical, one should first determine the qualities necessary for its best efficiency, and one should select the employee only as he possesses these qualities. Similarly, one should not promote an employee to a more important position without being sure that he is fitted for it, both as to natural qualities and technical knowledge.

CHOICE OF A MANAGER FOR A LOCAL AGENCY OF THE LEAGUE

One needs a local mnager. There are many candidates. Whom is one to choose, and on what grounds?

I consider that the manager should be an American by birth, and a person of some eminence, and that he should be one-tenth engineer, one-tenth business man, and eight-tenths "man of the world." It is useless and perhaps even harmful for him to be too familiar with the language of the country. He will make more of an effect if he is clearly an American. In the social position he will occupy there will be many persons who speak English fairly well, and will be glad to "show off" by associating with him.

The manger should be capable of going everywhere in society, making speeches, telling after-dinner stories, becoming intimate with rich bankers and business men, who are so unapproachable for those they consider their inferiors. He should play tennis, chess, cards, billiards, etc. These qualities are of the greatest value for his particular position.

I have had the opportunity of watching the procedure of a man who was particularly successful in this line. He was an excellent student of human nature, and made good use of his knowledge. His favorite method was to catch his "victim" at a dinner, where he would manage to place himself next to him. Suiting his conversation to the personal tastes of his neighbor, by the end of the dinner they would be the best of friends. Then, and then only, he would casually mention the subject of business. Nine times out of ten he was invited to the other's office, and on presenting his card there he was immediately received, while others waited in the outer office. In recalling to his "dear friend" the pleasant time they had passed together, he had no difficulty in obtaining orders for supplies, or any information he might wish.

CHOOSING SUBORDINATE EMPLOYEES

I have noticed that in all large businesses of all countries care is taken to form a brilliant general staff (managers, engineers, etc.), but that the education of the subordinate force is neglected. This is a great error. Just as in a war the success of an army does not depend only on its commander, the manager of an office needs able subordinates capable of carrying out his orders.

I have studied many office forces, and have usually found that most all clerks do only a small fraction of what they are actually capable of doing, and still less of what they might have done if they had been constantly *advised, guided,* and *supervised,* until thoroughly familiar with their work. Attempts have recently been made to guide workmen in factories; when will the same be done for clerks in offices?

The manager must study his employees, keep those who are of value or may be made of value, encourage them by bonuses or otherwise, and eliminate those who are only dead weight.

The employees who do only office work may be of any nationality whatever. The only thing to be considered is their merit. They must, of course, be familiar with the nature of the business, and must know both English and the language of the country in which they are employed.

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EDITORIAL COMMENT

ENGINEERS and men of business who have been misled into the belief that the appointment of a Naval Consulting Board, composed of some of our most distinguished civilian engineers and inventors, is a mere political move, and that the work of the body will probably amount to nothing, should dismiss that delusion without delay.

The first action of the Board, at its first session, was the adoption, by unanimous vote, of a resolution pledging each member not to discuss the technical work of the Board in the public prints—because every member quickly realized that they have no more right to discuss publicly the development work of the United States Navy, than would a consulting engineer in private practice have a right to talk of his clients' individual affairs.

The scheme of organization adopted also indicates the essentially practical character of their proposed activities. Seeing at once that it would be entirely impracticable for so large a body to act collectively in the investigation of a wide range of vitally important matters, it was agreed that fifteen committees should be appointed, as follows: On Chemistry and physics; Aeronautics, including aero motors; Internal combustion motors; Electricity; Mines and torpedoes; Submarines; Ordnance and explosives; Wireless and communications; Transportation; Production, manufacture and standardization; Ship construction; Steam engineering and ship propulsion; Life saving appliances; Aids to navigation; Food and sanitation.

A member of the Board best equipped to act as chairman of each of these committees will be selected, and these chairmen will be authorized by the Board to call to the aid of his committee the foremost civilian experts engaged in each field of chemical, mechanical, or industrial activity.

"Tools and the man I sing!"
—*T. Carlyle.*

NO country is seeking warfare less than the United States. No nation needs a war for the furtherance of its ambitions and prosperity less than the United States. For its actual subsistance this Nation could shut itself off from commerce with every other country, and, by developing its own resources to some slight degree, could continue to thrive in a Paradise of its own. But while we could, if put to it, live solely upon the produce of our country, other nations would experience a distinct hardship, and we would face a situation similar to that of China in 1840 and again in 1860 when the nations of the world demanded from it the right of trade. China, centuries behind in the knowledge of military and naval preparedness, relied solely upon the size of its "paunch," and, hence, was compelled to yield upon all points to the demands of the Powers. China has had over fifty years in which to develop forces sufficient to maintain its integrity, yet presumably the Chinese adherents of the peace-at-any-price movement are still in the ascendancy,

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for even this year we have seen the big flabby fellow completely dominated by the little fellow with the "punch."

We have, by virtue of Nature's kind graces, certain resources not possessed, or to a limited extent only, by other Nations. Some of these we have in quantities more than we need, and these we are willing to trade. But is it improbable that another nation, dissatisfied with the amount doled out to it, may demand more than we can spare, and seek to enforce its demands?

Again, there are very fair, fat lands in the continent to the south, which we are sworn to protect by virtue of the Monroe doctrine, and, as Mr. Saunders points out, those lands confidently look to us to maintain their freedom. That means that, in addition to the five thousand miles of our own shores, we may be called upon to protect the seventeen thousand miles or more of coast of the countries south. Is it at all improbable that, after the territorial adjustments are made at the close of this war, covetous eyes will be turned toward South America?

LAST winter the unemployment problem in the large cities (notably in New York, which seems to be the favorite stamping grounds of labor out of work) had reached a crisis. The war in Europe had fairly demoralized capital, and employers in general were laying off workmen, giving them little hopes of early re-employment. So general was this that even Wall Street, the money center of the Nation, discharged large numbers of its clerks, and the country was treated to the unusual spectacle of seeing "benefit funds" created for the use of those clerks. This year conditions are remarkably changed. The various charity organizations of New York have announced that they foresee no difficulty in caring for the comparatively few unemployed workers who will be seeking aid. And, again, the country is treated with the unusual in hearing the proposal to close the stock exchanges for several days seriously discussed in order that the over-driven clerks of Wall Street may catch up with their work!

We do not need to ask for the causes. Every manufacturer knows them. Immigration is falling off to an astonishing extent; emigration is large; and shops and factories are working overtime.

Austria, Italy, and the Balkan States, formerly our chief assets in recruiting the ranks of labor—skilled and unskilled—are now calling their able-bodied citizens back to military service. At the same time our factories are called upon to meet the demands not only for munitions for the warring countries, but also for the regular articles of commerce previously supplied by those countries as well as by our own.

We are facing an absolute shortage of labor. To what extent this shortage will continue cannot be foreseen, but it is safe to predict that it will be progressive. It is only beginning to be felt now. Next year it will presumably be worse than this. And if the war should end during the coming twelve months, our shortage will be greatly increased, for the most immediate need of the fighting countries will be for labor, and they will pay and must pay good prices to get it.

WE are not in sympathy with Henry Ford's anti-preparedness policy on national affairs, but we are absolutely in accord with the preparedness policies of the Ford shops in meeting the growing shortage of labor. Whether instigated purely by

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chance, or by foresighted judgment, or by altruistic motives, the five-dollar-a-day minimum wage of the Ford shops has removed them for the present at least from the fear of labor shortage. But that is only one feature of their methods, and one to which manufacturers in some sections of the country are even now being compelled to duplicate. The other is their mechanical preparedness.

One of the most striking features of Ford manufacturing methods, clearly and forcefully presented by Mr. Arnold in the series he ran in these pages last year, is the remarkable extent to which manual handling has been superseded by mechanical handling. Cranes, elevators, rollways, slide-ways, of every conceivable size and description interlace the huge plant, carrying each part to and through its particular process on to the next, doing away with a large number of unskilled workers and an infinite amount of congestion. Whether they be large or small, heavy or light, round or square, some form of conveyor has been designed to carry all parts smoothly and swiftly to the next step in the assembly.

The value of systematized mechanical handling methods is threefold: First, a reduction in the number of workmen is possible—the Ford plant dispensed with some 400 truckers, although of course a certain amount of skilled labor was required to operate the system; second, a saving in floor space—one of the beauties of mechanical handling lies in the fact that most of it is overhead or aerial, thus valuable floor space is provided for closer machine grouping; and third, absolute scheduling of parts in process is feasible—the conveyor system can be so timed as to bring every part to the place it is wanted at the time it is wanted.

Of course, there are many manufacturers who are keenly alive to the possibilities of mechanical conveyors —that is demonstrated by a visit to their factories—but the plants are legion in which no such features are in operation, or if installed are inadequate; in either case a careful study of the subject and a careful outlay for the system best adapted to the work would soon justify the equipment in comfort, convenience, and costs.

FOR a few days at the end of September New York had an attack of nerves and even the events of the War were shoved into second place in the news columns and in public discussion. The actual destruction on Europe's battlefields seemed less momentous than that which was threatened in the streets of the city by the two subway collapses; contractors, Public Service Commissioners, engineers of the Commission, the municipal government and the entire population of Manhattan became mightily concerned about what was going to happen next, and he who had to cross a planked-over street—in which the island abounds—did so with a silent prayer that the top might hold until he reached the other side. The danger seems well passed; weak places have been strengthened and the public is reassured, but unquestionably the engineers of the Commission have had their eyes opened. Naturally the technical periodicals have had a good deal to say about the events; and some rather positive expression of opinion by the editors of the *Engineering and Mining Journal* has been widely quoted. The *Journal* laid the trouble to the fact that mining engineers were not consulted as to the best methods of prosecuting work with which they were well acquainted. Allowing for some bias on the part of the *Journal*, the position is in gen-

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eral well taken. The Seventh Avenue collapse called attention to some mighty poor timbering and that in Broadway showed a woeful lack of the ability to judge bad ground, an ability which refuses the curb of formula and logic and comes only with long experience and a peculiar capacity for observation and inductive reasoning entirely subconscious.

It is true that the head of the Commission engineers, Alfred Craven, has had mining experience and that too in a camp famous the world over for its timbering, namely, the Comstock. Mr. Craven's time, however, has probably been taken up with more important matters than the details of the subway timbering systems. It is also true that on the Commission's staff and also on the contractors' there are numerous young mining engineers forced into this work by the recent depression in the mining industry. The most of these, however, were not in responsible positions. Indeed, there seems to have been nobody in charge of the timbering who had had much experience with the support of mine workings.

Thus much in censure; on the other side it must be stated that the work of the subway excavation, like that of the Catskill aqueduct, has on the whole been carried on with a remarkable freedom from accidents that affected the public. To trench, line, and equip with track, pipes, and stations, the busiest streets in New York while traffic proceeds uninterrupted overhead is an engineering feat of the first magnitude. The intricacy of the problem is quite beyond the imagination of the layman, and the work aside from the breaking and supporting of the rock is outside the experience of even the mining engineer, who has to consider usually only the safety of his men and his mine.

We are curious as to how safe the subway work has been for the workmen employed. We have seen no figures bearing on this point. A few years ago an investigation of the Aqueduct work revealed a woefully high accidental death rate, higher than that for mining over the United States at large—and the United States has about the worst record of any country in the world—and this in spite of the fact that the inherent danger was much less. Has the Subway work exacted so high a toll of human lives in its prosecution?

NO higher tribute could be given any man than that given Frederick W. Taylor, by H. L. Gantt at the Memorial Meeting of the Society for the Promotion of Scientific Management, in Philadelphia, October twenty-second. In speaking of Mr. Taylor's character, Mr. Gantt said: "If I were asked to point out his most prominent characteristic, I should say that it was his ability to prosecute the task he had set himself, regardless of the lack of sympathy of his friends and the criticism of his enemies.

"Having determined on a course of action he pursued it regardless of consequences; and inasmuch as such courses were planned by a clear head and followed with an iron will, he often accomplished results far in excess of what even his most earnest supporters thought possible."

THE second paper on Management of Central Stations by Walter N. Polakov, which was announced for this issue, will appear in the December number.

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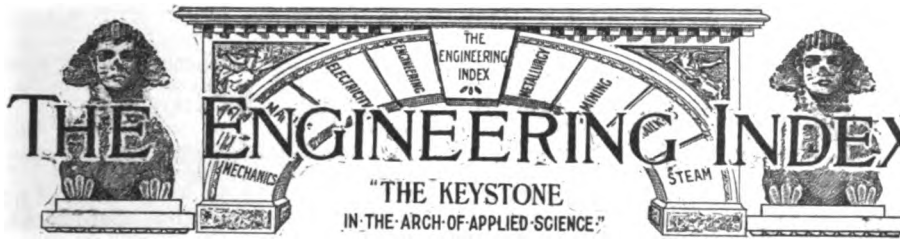

Including a current record of new books.

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☛ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

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CIVIL ENGINEERING

BRIDGES

Bascule

An Interesting Structure Over the Buffalo River. Strauss bascule under construction by the Lackawanna R. R. Ills. 2500 w. Ry Age Gaz—Sept. 10, 1915. No. 64119.

A Double-Leaf Bascule Railway Bridge. Details of bridge over U. S. ship canal at Sault Ste. Marie. Ills. 800 w. Engr, Lond—Sept. 10, 1915. No. 64383 A.

Concrete

Design Features of the Alger Bridge, Columbus, Ohio,—A 1166-ft. Reinforced Concrete Structure. General features and details of design. Ills. 2500 w. Engng & Con—Sept. 15, 1915. No. 64240.

Failures

Contractors to Replace $20,000 Worth of Concrete Bridge Work. J. H. Ames. Condemned work on Iowa state highways. Ills. 2500 w. Con-Cem Age—Sept., 1915. No. 64144.

Floors

Surfaces of Floors for Bridges. Clifford Older. Examples of types; with discussion. Ills. 24 pp. Am Rd Bld Assoc Pro Dec., 1914. No. 64096 A + F.

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Footbridges

Cost of Railway Footbridges. Types and costs of separate parts. Ills. 4400 w. Engr, Lond—Aug. 27, 1915. Serial, 1st part. No. 63985 A.

Foundations

The Construction of the Foundations of the Bear River Bridge, Near Digby, Nova Scotia. Difficult caisson and pier work during severe weather. Ills. 2500 w. Can Engr—Sept. 2, 1915. No. 63928.

Quebec

Progress on the New Quebec Bridge. H. P. Borden. Review of 1915 work. Ills. 700 w. Can Engr—Sept. 23, 1915. No. 64550.

Quebec Bridge Work in 1915. Statement of progress. Ills. 500 w. Eng News—Sept. 2, 1915. No. 63895.

Railway

Some Eastern Bridges, Canadian Pacific Railway. Examples. Ills. 1100 w. Can Engr—Sept. 16, 1915. No. 64307.

Some Steel Railway Viaducts in Western Canada. Canadian Pacific structures. Ills. 1500 w. Can Engr—Sept. 9, 1915. No. 64145.

Raising

Raising a Concrete Girder Bridge with Screw Jacks. W. R. Mason. Work in the Philippines. 500 w. Engng & Con—Sept. 15, 1915. No. 64241.

Swing

Draw Span of Harlem River Bridge Floated to Place. Rapid work. Ills. 1200 w. Eng Rec—Sept. 4, 1915. No. 63882.

Viaducts

Fast Concreting on Brooklyn-Brighton Viaduct, Cleveland. 1700-ft. viaduct built in two longitudinal halves. Ills. 3000 w. Eng News—Sept. 9, 1915. No. 64111.

The Twelfth Street Trafficway Viaduct, Kansas City, Missouri. Discussion of E. E. Howard's paper. 5000 w. Pro Am Soc of Civ Engrs—Sept., 1915. No. 63507 D.

CONSTRUCTION

Boring

Test Boring Data, Shoal Lake Aqueduct. Cost data and equipment records. 700 w. Can Engr—Sept. 2, 1915. No. 63925.

Camps

Six Types of Construction Camp Garbage and Refuse Incinerators. From pamphlet issued by Commission of Immigration and Housing of California, San Francisco. Ills. 1000 w. Engng & Con—Sept. 1, 1915. No. 63845.

Concrete

The Construction of Small Concrete Houses at San Juan, P. R. Earl K. Burton. Simple construction methods and costs. Ills. 2000 w. Con-Cem Age—Sept., 1915. No. 64143.

Dams

Notes on the Construction and Design of Dams (Einiges über Bau und Berechnung von Stauwehr-Anlagen). H. E. Gruner. General methods and specific examples. Ills. 2000 w. Schweiz Bau—Aug. 14, 1915. No. 64018 B.

Explosives

Explosives on the Catskill Aqueduct. J. S. Longthorn. Methods of handling. Discussion. Ills. 14000 w. Brooklyn Engrs' Club, No. 124—1914. No. 63822 N.

Fences

Practical Suggestions Given for Building Wire Fences and Concrete Posts. Ralph N. Wheeler. Inclosing Catskill aqueduct right-of-way. 2500 w. Eng Rec—Sept. 18, 1915. No. 64314.

Geology

Geology as an Aid to Tropical Engineering. Warren D. Smith. Practical bearing upon problems. Ills. 5500 w. Min Pr—Sept. 18, 1915. No. 64387.

New Orleans

The Renaissance of New Orleans. Stanley Clisby Arthur. Developments costing over $100,000,000. Ills. 3500 w. Mfrs' Rec—Sept. 23, 1915. No. 64479.

Piers

New York's New Piers. Details of work in progress. Ills. 2000 w. Engr, Lond—Aug. 27, 1915. No. 63983 A.

Piling

Pile Driving in Soil, Experiments with a New Foundation (Die Rammwirkung im Erdreich, Versuche auf neuer Grundlage). Karl Zimmermann. Details of method and apparatus. Ills. 1200 w. Beton u Eisen—Aug. 3, 1915. Serial, 1st part. No. 64008 B.

Pipe Lines

California Oil Pipe Line, 200 Miles Long, Built in Record Time of 15 Months. Route crossed mountainous country. Ills. 2500 w. Eng Rec—Sept. 4, 1915. No. 63881.

Reclamation

Simple Construction Reclaims 7000 Acres of Rich Land at Low Cost. H. M. Burwell. Work in British Columbia. 1200 w. Eng Rec—Sept. 11, 1915. No. 64163.

Scaffolding

Scaffolding and Lifts in New South Wales. From annual report to Legislative Assembly. 2500 w. Archt, Lond—Sept. 10, 1915. No. 64364 A.

Speedways

Motor Race-Track at Chicago. Two-mile course; rapid construction. Ills. 2500 w. Eng News—Sept. 9, 1915. No. 64113.

Stadiums

San Diego's Municipal Stadium. F. A. Rhodes. General design and construction. Ills. 2200 w. Eng News—Sept. 23, 1915. No. 64471.

Towers

Building a Lookout Tower of Reinforced Concrete (Erbauung eines Aussichsturmes in Eisenbeton). H. Kügler. Details of calculations and construction. Ills. 1500 w. Beton u Eisen—Aug. 3, 1915. Serial, 1st part. No. 64007 B.

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Maine Central Roundhouse, Waterville, Maine.

Plans drawn by Engineering Department of the Maine Central Railroad at Portland, Maine.
General Contractors: Horace Purinton & Co., Waterville, Me.
Roofer: Wallace A. Hill, Fairfield, Maine.

A severe roofing test—

The roof of a railroad roundhouse *must be a good roof*—otherwise its life is short. Not only must it withstand the ordinary weather hazards but in addition must resist the sulphurous gases of coal smoke, the flying sparks, the intense heat from the locomotives and the condensation of moisture from the steam exhausts. It must resist all these attacks from both above and below.

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These roofs take the base rate of the insurance and are approved by the Underwriters' Laboratories. We should like to send every architect, engineer and building owner a copy of the Underwriters' Laboratories report on Barrett Specification Roofs. Address our nearest office.

Special Note We advise incorporating in plans the full wording of The Barrett Specification, in order to avoid any misunderstanding. If any abbreviated form is desired, however, the following is suggested: ROOFING—Shall be a Barrett Specification Roof laid as directed in printed Specification, revised August 15, 1911, using the materials specified and subject to the inspection requirement.

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TRADE B MARK

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Through the Galveston Hurricane
Uninjured

After the wooden grain elevator of the Southern Pacific at Galveston burned, the Company decided quickly to replace it with an everlasting structure, and the massive elevator here shown was completed in June, 1915. When the recent great tropical storm struck Galveston, when all communication with mainland was cut off and the fate of the city rested on the endurance of the sea-wall, it was feared that tall buildings would be demolished. But the big grain elevator, built with 22,000 barrels of

ALPHA THE GUARANTEED PORTLAND CEMENT

stood as if it were cut out of solid stone, though sea water flooded the basement and its windows were smashed by flying debris. The sea-wall which bore the brunt of the storm and is credited with saving Galveston from utter destruction, contained 28,500 barrels of ALPHA CEMENT. Again and again, ALPHA concrete constructions have stood the most trying tests.

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Burning of Wooden Structure Replaced by the ALPHA Concrete Elevator

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Trenching Machines

New Trenching Machines. Two machines for narrow, deep work. Ills. 1100 w. Eng News—Sept. 2, 1915. No. 63892.

Tunnels

Tunnelling and Geology. E. Lauchli. Importance of geologic surveys. Ills. 6000 w. Can Engr—Sept. 16, 1915. No. 64306.

Study on the Vibration Set Up by the Passage of Trains through Tunnels (Étude sur la vibration due au passage des trains dans les tunnels). Paul Seurot. Account of work on the Pennsylvania Hudson tunnels. 10 pp. Rev Tri Can—Aug., 1915. No. 64019 N.

Concrete-Lined Tunnels on the Clinchfield Road. Unusual methods. Ills. 2000 w. Mfrs' Rec—Sept. 9, 1915. No. 64110.

Lining of Sandy Ridge Tunnel, C. C. & O. Ry. Methods of work. Ills. 2500 w. Ry Rev—Sept. 11, 1915. No. 64170.

Warehouses

Electricity in Large Steel Warehouses. Motor equipment of new Carnegie warehouse at Boston. Ills. 1200 w. Elec Rev & W Elect'n—Sept. 11, 1915. No. 64156.

Design and Construction of Midland Warehouse, Chicago, Ill. Plant and methods. Ills. 1200 w. Engng & Con—Sept. 8, 1915. No. 64105.

New Steel and Concrete Structure to Furnish Nearly Sixteen Acres of Floor Space. Bingham warehouse in Cleveland. Ills. 1500 w. Eng Rec—Sept. 18, 1915. No. 64312.

MATERIALS OF CONSTRUCTION

Corrosion

Structural or Mechanical Theory of the Effect of Rust on Cast Iron and Wrought Iron and Steel. R. C. McWane and H. Y. Carson. Ills. 2000 w. Am Found Assn—Sept. 28, 1915. No. 64534 N.

The Influence of Different Elements on the Corrosion of Iron. L. C. Wilson. How various metals and metalloids act. 4500 w. Engng Mag—Oct., 1915. No. 64581 A.

Forest Reserves

The Forests of the United States. Leonard Lundgren. The work of the Forest Service. Ills. 4800 w. Engng Mag—Oct., 1915. No. 64445 A.

Metal Protection

Protective Coatings for Metal. H. B. C. Allison. Résumé of most effective processes. 2000 w. Gen Elec Rev—Sept., 1915. No. 63778 A.

Paints

Experience with Lead and Tar Paints on Hydraulic Apparatus, Minidoka Power Plant, U. S. R. S. From report by Barry Dibble, in *The Reclamation Record.* Information concerning difficulties. 1200 w. Engng & Con—Sept. 8, 1915. No. 64104.

Sand and Gravel

The Production of Sand and Gravel in 1914. G. F. Loughlin. Report, with tables. 3500 w. U S Geol Surv, II: 18—Aug. 26, 1915. No. 63827 N.

Silica Brick

Manufacture and Tests of Silica Brick for the Byproduct Coke Oven. Kenneth Seaver. Materials, methods of manufacture, and tests. Ills. 5000 w. Bul Am Inst of Min Engrs—Sept., 1915. No. 64197 D.

Timber

Longleaf Pine Distinguished Visually from Loblolly or Shortleaf. Arthur Koehler. Reliable test without microscope. Ills. 1800 w. Eng Rec—Sept. 11, 1915. No. 64159.

Humidity-Control Process for the Drying of Lumber. W. H. Lewis. Norfolk & Western kiln at Roanoke, Va. Ills. 1000 w. Ry Age Gaz—Sept. 3, 1915. No. 63904.

MEASUREMENT

Arches

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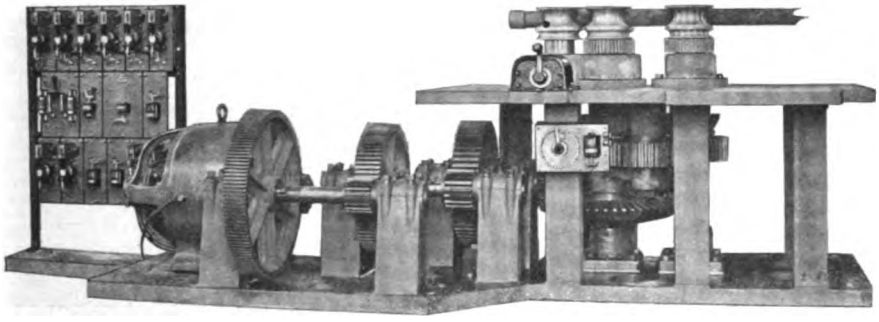

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Boilers

Loockin Marine Boiler and Internal Superheater. A. B. Willits. New type of Scotch boiler having superheater within the shell. Ills. 1800 w. Power—Aug. 31, 1915. No. 63773.

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AERONAUTICS

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Axles

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Mean Effective Pressure and Piston Speed. Remarkable uniformity. 2200 w. Horseless Age—Sept. 1, 1915. No. 63931.

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Motor Car Houses. J. B. Jolly. Four suggested designs. Ills. 3500 w. Autocar—Sept. 4, 1915. No. 64318 A.

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Power Traction in War. Sir John Macdonald. Advantages and services rendered. 4500 w. Jour Roy U Serv Inst—Aug., 1915. No. 64180 N.

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COMBUSTION MOTORS

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Sub-Bituminous Coal and Saw-mill Waste in Producer Plant. George S. Wilson. Results of tests on 27-hp. producer

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plant using low-grade fuels. Ills. 1500 w. Power—Sept. 28, 1915. No. 64587.

Gas Engines

Gas Engines as Prime Movers for Power and Electric Stations, and Their Application to the Modern Gas Pumping Station. L. S. Stiles. The ten-million cubic-foot Newtown gas holder is described, and the gas pumping station. Ills. 8500 w. Brooklyn Engrs' Club, No. 125—1914. No. 63823 N.

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The Maximum Content of Hydrocarbons in Generator Gases (Die Maximalgehalte des Generatorgases an Kohlenwasserstoffen). Fritz Hoffmann. Analyses and study. 2200 w. Feuerungs—Aug. 15, 1915. Serial, 1st part. No. 64045 B.

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A Drill Room That Requires 23,000 Square Feet of Direct Radiation. George B. Rice. Problems at University of Illinois. Ills. 2500 w. Heat & Vent Mag—Sept., 1915. No. 64256.

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Performance of Ammonia Compressor. H. S. Eames. Work and efficiency ratio. 1200 w. Ice & Refrig—Sept., 1915. No. 63947 A.

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Three Methods of Measuring Radiant Heat from Gas Fires. Brief descriptions. Ills. 1200 w. Heat & Vent Mag—Sept., 1915. No. 64258.

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Practical Use of Thermometers in Refrigerating Plants. Peter Neff. Where they should be used and advantages. 1400 w. Power—Sept. 21, 1915. No. 64338.

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Developments in Air-Lift Pumping. S. W. Symons. Ills. 1500 w. Prac Engr, Chicago—Sept. 15, 1915. No. 64174.

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Proposed Government Testing Flume for Hydraulic Turbines Not Needed. H. Birchard Taylor. Holyoke flume ample for research work. 3000 w. Eng Rec—Sept. 11, 1915. No. 64160.

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Some Remarks Regarding the Permissible Phosphorus Limit in Malleable Iron Castings. Enrique Touceda. Investigations. Ills. 2500 w. Am Found Assn—Sept. 28, 1915. No. 64540 N.

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Repairing a Crank-Axle. J. D. Smith. Methods adopted. Ills. 2000 w. Mech Wld—Sept. 10, 1915. No. 64573 A.

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Dies

Rectangular Drawing and Trimming. Joseph M. Stabel. Laying out dies and determining number of operations. Ills. 3300 w. Mach, N Y—Sept., 1915. No. 63797 A.

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Drop Forgings. Use for railway rolling stock. Ills. 1500 w. Ry Gaz, Lond—Aug. 27, 1915. Serial, 1st part. No. 63975 A.

Mechanical Production of Drop-Forging Dies. Edward K. Hammond. Keller automatic profiling machine and method of operation. Ills. 3000 w. Mach, N Y —Sept., 1915. No. 63791 A.

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A Converter Foundry of Large Capacity. Edwin F. Cone. Intensive production methods of Reading Steel Casting

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A Flexible Heat-Treating Installation. Link-Belt works at Indianapolis. Ills. 1200 w. Ir Age—Sept. 2, 1915. No. 63848 A.

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Molding and Casting Large Tunnel Segments. Louis J. Josten. Cost greatly reduced. Ills. 1200 w. Foundry—Sept., 1915. (Special.) No. 64166 A.

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Patternmaking for Molding Machine Work. E. I. Chase. Favors cast iron patterns. Economical means. 3000 w. Am Found Assn—Sept. 28, 1915. No. 64525 N.

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Messrs. Hughes and Lancaster's Acrefair Engineering Works. Works for manufacture of steam-engines, air-compressors, and apparatus for Shone system of sewage disposal. Ills. 2200 w. Engng—Aug. 20, 1915. No. 63868 A.

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The Value of Preliminary Sketches and Layouts in Production Work. Albert A. Dowd. Modern efficiency methods. Ills. 2000 w. Horseless Age—Sept. 1, 1915. No. 63932.

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Covers metallographic examination; taking of special samples, and analysis of all kinds of ferro-alloys for the common constituents.

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$24,000,000 South Philadelphia Railroad Improvement Now Well Under Way. What project involves. Map & Ills. 2500 w. Eng Rec—Sept. 11, 1915. No. 64162.

PERMANENT WAY AND BUILDINGS

Coal-Tips

Hydraulic Coal-Tips at Barry Docks. Latest standard practice. Ills. 800 w. Engng—Sept. 10, 1915. No. 64378 A.

Freight Station

Double-Deck Freight Station at Pittsburgh. Office and station for Pennsylvania Conemaugh division. Ills. 1400 w. Eng News—Sept. 9, 1915. No. 64114.

Grade Separation

Track Elevation at Lynn, Mass. Charles B. Breed. History of Boston &

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Maine projects. Ills. 3900 w. Eng News—Sept. 16, 1915. No. 64280.

Grade Crossing Elimination in North Toronto, Ontario. Elevation of track on Canadian Pacific. Ills. 2500 w. Ry Age Gaz—Sept. 24, 1915. No. 64511.

Offices

New Offices in the Grand Central Terminal Area. Features of large terminal. Ills. 1200 w. Ry Mas Mech—Sept., 1915. No. 64515 A

Rails

Systematic Reporting of Rail Failures. Paul M. La Bash. Standard forms of reports. Ills. 4000 w. Ry Engng & Main of Way—Sept., 1915. No. 64188 A.

Shops

Locomotive and Car Shops of the Canadian Pacific Railway. Angus shops, Montreal, and Ogden shops, near Calgary. Ills. 2000 w. Can Engr—Sept. 2, 1915. No. 63926.

Terminals

A Notable Group of Railway Terminals. Canadian Pacific Ry. terminals at Quebec, Montreal, Winnipeg, and Vancouver. Ills. 2500 w. Can Engr—Sept. 23, 1915. No. 64552.

Canadian Pacific Terminal. Improvements at Vancouver. Details of increased facilities. Ills. 1800 w. Ry Gaz, Lond—Aug. 27, 1915. No. 63976 A.

Ties

Tie Impregnation with Special Regard to the Calculation of Treatment Plants (Die Holzschwellentränkung unter besonderer Berücksichtigung der Berechnung von Schwellentränkanlagen). M. Igel. General discussion. Ills. 2000 w. Glasers Ann—Sept. 1, 1915. No. 64089 B.

Track

Special Steels. W. C. Cushing. Use for track points, crossings, etc. Ills. 193 pp. Bul Am Ry Engng Assn—July, 1915. No. 64226 N.

Track Tools

The Up-Keep of Track Tools. M. E. Carroll. Repairing methods. Ills. 2000 w. Ry Rev—Sept. 11, 1915. No. 64171.

Track Work

Arranging Seasonal Track Work. W. H. Kofmehl. Work of each season outlined. 1500 w. Ry Engng & Main of Way—Sept., 1915. No. 64187 A.

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Finley Yard of the Southern Railway at North Birmingham, Ala. Extensive engine terminal and freight yard. Ills. 2500 w. Ry Rev—Sept. 18, 1915. No. 64357.

TRAFFIC

Economic Improvements

Superheater Locomotives and Grade Revision. Paul M. La Bach. Traffic problems and possible savings. 2000 w. Ry Age Gaz—Sept. 10, 1915. No. 64120.

Germany

Great Achievements of German State Railroad Lines. Frederic William Wile. Work during war. 2500 w. Ry Age Gaz—Sept. 3, 1915. No. 63903.

Train Loading

Scientific Train Loading; Tonnage Rating. O. S. Beyer. Questions of grades, curves, train resistance, etc. 14 pp. Trav Eng Assoc—Sept., 1915. No. 64034 N.

MISCELLANY

Expositions

The Railways and the California Expositions. First of two articles on preparations made to handle traffic. Ills. 4500 w. Ry Age Gaz—Sept. 10, 1915. Serial, 1st part. No. 64118.

Railroads and Public

The Railroad—A Public Servant. W. E. Williams. Read before Am. Assn. of R. R. Supts. 2000 w. Pro St Louis Ry Club—Aug. 13, 1915. No. 64210.

South Africa

South African Railway Operations in 1914. Information from the report of W. W Hoy. Map. 1800 w. Ry Gaz, Lond—Sept. 10, 1915. No. 64570 A.

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The Qualifications of a Terminal Superintendent. S. W. Roberts. Analysis of elements to secure best results. 2500 w. Ry Age Gaz—Sept. 3, 1915. No. 63905.

STREET AND ELECTRIC RAILWAYS

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The Auto-Bus as an Auxiliary to Interurban Railways. A. W. Leonard. Use of feeders. Ills. 300 w. Elec Ry Jour—Sept. 18, 1915. No. 64355.

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Calgary's Municipal Street Railway. W. E. Hardenburg. Shows profit. Ills. 2000 w. Munic Jour—Sept. 9, 1915. No. 63991.

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Use of the Vacuum System for Cleaning Cars in San Francisco. F. W. Allen. Improvement and economy. Ills. 500 w. Elec Ry Jour—Sept. 18, 1915. No. 64346.

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Car Maintenance on the San Francisco-Oakland Terminal Railways. George St. Pierre. Inspection, overhauling and repairs. Ills. 1500 w. Elec Ry Jour—Sept. 18, 1915. No. 64349.

Maintenance of 1500-Volt D. C. Cars by the Southern Pacific Company. E. Sears. Early difficulties and elimination. 1500 w. Elec Ry Jour—Sept. 18, 1915. No. 64351.

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Reduction in Power Cost Effected by the Use of Coasting Recorders. W. R. Alberger. Benefits derived from practice. 800 w. Elec Ry Jour—Sept. 18, 1915. No. 64347.

The Use of Coasting Recorders Results in Economies at Vancouver. W. G. Murrin. Advantages. Ills. 800 w. Elec Ry Jour—Sept. 18, 1915. No. 64356.

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Businesslike Methods in Handling Freight by Electric Railroads. J. McMillan. Methods on Pacific Elec. Ry. Ills. 3500 w. Elec Ry Jour—Sept. 18, 1915. No. 64342.

Interurban

The Portland and Lewiston Interurban. A 40-mile line in Maine. Ills. 1800 w. Elec Ry Jour—Sept. 25, 1915. No. 64554.

Jitneys

Autos and the Electric Car. John A. Beeler. Advantages and comparative costs in Denver, Colo. 2500 w. Elec Ry Jour—Sept. 18, 1915. No. 64335.

Pacific Coast

The Electric Railway Properties of the Pacific Coast. Some of the city and interurban systems. Ills. 60 pp. Elec Trac—Sept., 1915. No. 64316.

Scientific Management

Departmental Work Planning System at Portland. F. P. Maize. Modifications of Taylor system successfully applied. Ills. 1000 w. Elec Ry Jour—Sept. 18, 1915. No. 64353.

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Signal, Bonding and Contact Rail Notes on the Northwestern Pacific. F. T. Vanatta. Excellent record of a. c. track-circuit system. Ills. 1000 w. Elec Ry Jour—Sept. 18, 1915. No. 64350.

Special Work

Practical Views of Special Work. I. The Tongue Switch. R. P. Williams. Suggestions. Ills. 1200 w. Elec Ry Jour—Sept. 25, 1915. Serial, 1st part. No. 64556.

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Steel Cars for Chicago and Milwaukee Electric Railroad. Interurban high-speed operation. Ills. 2200 w. Elec Ry Jour—Sept. 4, 1915. No. 63938.

New All-Steel Passenger Cars for the Pacific Electric Railway. Fred F. Small. Details. Ills. 2000 w. Elec Ry Jour—Sept. 18, 1915. No. 64343.

Substation

Automatically Controlled Substations With Particular Reference to Their Application to Interurban Electric Railways. E. W. Allen and Edward Taylor. Installed in the Union, Ill., substation. Ills. 5800 w. Pro Am Inst of Elec Engrs—Sept., 1915. No. 64255 D.

Subway Cave-Ins

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Subways

New York Subway Ventilation. James G. Dudley. History and proposed scheme. Ills. 39 pp. Sept., 1915. No. 64075 N.

Track

Greater Uniformity in the Permanent Way of Tramways (Meerdere eenheid in den bovenbouw van tramwegen). E. C. W. van Dijk. Sections, splice bars, spikes, etc. Ills. 800 w. Ingenieur—Sept. 4, 1915. No. 64082 B.

Laying Street-Railway Track Without Ties. E. R. Rorton, Jr. Embedded in concrete. Ills. 5400 w. Eng News—Sept. 23, 1915. No. 64474.

San-Francisco-Oakland Terminal Railways' Way Standards. George H. Binkley. Tracks and paving. Ills. 2500 w. Elec Ry Jour—Sept. 18, 1915. No. 64348.

Traffic Analysis

Traffic Analysis and Schedule Planning at Portland, Oregon. Fred Cooper. Schedules compiled from data furnished by conductors and inspectors. 1200 w. Elec Ry Jour—Sept. 18, 1915. No. 64352.

Tramway History

Some Notes on Early Tramway History. T. B. Goodyer. Also an account of "The Opening of the First Tramway in Europe." Refers particularly to the tramway in Birkenhead, England. Ills. 5000 w. Tram & Ry Wld—Sept. 9, 1915. No. 64368 A.

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American Electrochemical Society. South Bethlehem.
American Foundrymen's Association. Cleveland.
American Gas Light Journal. *w*. New York.
American Inst. of Architects. *yr*. New York.
Amer. Jour. of Public Health. *m*. New York.
Amer. Jour. of Science. *m*. New Haven.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. d Arch Ital. *s-m*. Rome.
Applied Science. *m*. Toronto.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architecture and Building. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automobil Rundschau. *s-m*. Berlin.

Beton und Eisen. *s-m*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. New York.
Brickbuilder. *m*. Boston.
Bull. Am. Inst. Mining Engrs. *m*. New York.
Bull. Am. Iron & Steel Inst. *m*. New York.
Bull. Am. Ry. Engng. Assn. *m*. Chicago.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bull. Can. Min. Inst. *m*. Montreal.
Bull. Soc. Int. d'Électriciens. *m*. Paris.
Bulletin of the Univ. of Wis. Madison.
Bull. Int. Railway Congress. *m*. Brussels.
Bull. Univ. of Illinois. Urbana, Ill.
Bureau of Mines. Washington.
Bureau of Standards. Washington.

Canadian Engineer. *w*. Toronto and Montreal.
Canadian Mining Journal. *b-w*. Toronto.
Chem. Met. Min. Soc. S. Af. *m*. Johannesburg.
Coal Age. *w*. New York.
Colliery Engineer. *m*. Scranton.
Colliery Guardian. *w*. London.
Commercial Vehicle. *s-m*. New York.
Commonwealth Engineer. *m*. Melbourne.
Compressed Air. *m*. New York.
Concrete-Cement Age. *m*. Chicago.
Cornell Civil Engineer. *m*. Ithaca.

Dept. of Agri. Washington.

Economic Geology. *s-q*. New Haven.
Electrical Engineering. *m*. New York.
Elec. Review and W. Elec'n. *w*. Chicago.
Electrical Review. *w*. London.
Electrical World. *w*. New York.
Electric Journal. *m*. Pittsburgh, Pa.
Electric Railway Journal. *w*. New York.
Electric Traction. *m*. Chicago.
Electrician. *w*. London.
Elektrische Kraftbetriebe u Bahnen. *w*. Munich.
Elektrochemische Zeitschrift. *m*. Berlin.
Elektrotechnik u Maschinenbau. *w*. Vienna.
Elektrotechnische Rundschau. *w*. Potsdam.
Engineer. *w*. London.
Engineering. *w*. London.
Engineering and Contracting. *w*. Chicago.
Engineering Contractor. *m*. New York.
Engineering Magazine. *m*. New York and London.
Engineering and Mining Journal. *w*. New York.
Engineering News. *w*. New York.
Engineering Record. *w*. New York.
Eng. Soc. of Western Penn. *m*. Pittsburgh.

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Feuerungstechnik. *s-m.* Leipzig.
Foundry. *m.* Cleveland, Ohio.

Gas Age, *b-m.* New York.
General Electric Review. *m.* Schenectady.
Génie Civil. *w.* Paris.
Geological Survey. Washington.
Giesserei-Zeitung, *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Gluckauf. w. Essen, Germany.

Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.

Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Turin.
Industria. *w.* Milan.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trade Review. *w.* London.
Iron Trade Review. *w.* Cleveland, Ohio.

Jour. of Accountancy. *m.* New York.
Jour. Am. Brass Founders' Assn. Buffalo.
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Jour. Am. Soc. of Naval Engrs. *qr.* Washington.
Jour. Asso. Eng. Societies. *m.* St. Louis.
Jour. Boston Soc. of Civil Engrs. *m.* Boston
Jour. Cham. Mines, W. Austral. *m.* Kalgoorlie.
Jour. Cleveland Engineering Society. *b-m.* Cleveland.
Jour. Engng. Soc. of Penna. *m.* Harrisburg.
Journal of Geology. *s-q.* Chicago.
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Journal N. E. Water Works Assn. *qr.* Boston.
Journal of the Society of Arts. *w.* London.
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Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Jour. Western Soc. of Engineers. *b-m.* Chicago.
Jour. of Worcester Poly Inst. Worcester, Mass.

La Nature. *w.* Paris.

Machinery. *m.* New York.
Madison Engineer. *m.* Madison.
Manufacturers' Record. *w.* Baltimore.
Marine Engr. and Naval Archt. *m.* London.
Marine Review. *m.* Cleveland, Ohio.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *b-m.* New York.
Mining and Engineering World. *w.* Chicago.
Mining and Scientific Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* London.
Monitore Tecnico. *t-m.* Milan.
Montanistische Rundschau. *w.* Vienna.
Motorwagen. *t-m.* Berlin.
Municipal Engineering. *m.* Indianapolis.
Municipal Journal. *w.* New York.

National Engineer. *m.* Chicago.
National Founders Association. *m.* Chicago.
Natl. Mach. Tool Bldrs. Assn. Worcester.
Nature. *w.* London.

Power. *w.* New York.
Practical Engineer. *s-m.* Chicago.
Practical Engineer. *w.* London.
Pro. Am. Inst. Electrical Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Water Works Assn. *yr.* Baltimore.
Pro. Brooklyn Engineers' Club. *yr.* New York.
Pro. Central Railway Club. *b-w.* Philadelphia.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. West. Pennsylvania. *m.* Pittsburgh.
Pro. Inst. of Civil Engineers. London.
Pro. Inst. of Electrical Engineers. London.
Pro. Inst. of Mechanical Engineers. London.
Pro. Inst. of Mining & Metallurgy. *m.* London.
Pro. Lake Superior Min. Inst. Ishpeming.
Pro. New York Railway Club. *m.* New York.
Pro. Railway Club of Pittsburgh. *m.* Pittsburgh.
Pro. St. Louis Railway Club. *m.* St. Louis.
Pro. U. S. Naval Inst. *qr.* Annapolis.
Pro. Western Railway Club. *m.* Chicago.

Quarry. *m.* London.
Queensland Government Mining Jour. *m.* Brisbane.

Railway Age Gazette. *w.* New York.
Railway Age Gazette (Mech. Ed.). *m.* New York.
Railway and Locomotive Engng. *m.* New York.
Railway Engr. *m.* London.
Railway Engng. & Maintenance of Way. *m.* New York.
Railway Gazette. *w.* London.
Railway Master Mechanic. *m.* New York.
Railway Review. *w.* Chicago.
Revista Marittima. *m.* Rome.
Rev. d'Electrochimie et d'Electrométall. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Générale des Chemins de Fer. *m.* Paris.
Revue Générale des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.

Safety Engng. *m.* New York.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *qr.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific American Supplement. *w.* New York.
Shipbuilder. *m.* Newcastle-on-Tyne.
Sibley Journal of Mech. Engng. *m.* Ithaca.
Signal Engineer. *m.* Chicago.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken.
Surveyor. *w.* London.

Telephone Engineer. *m.* Chicago.
Telephony. *w.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Soc. Nav. Arch'ts & Mar. Engrs., N. Y.
Trans. Illuminating Engng. Soc. New York.
Trans. Inst. Civil Engrs. of Ireland. Dublin.
Trans. Inst. of Engrs. & Ship. in Scotland. Glasgow.
Trans. Inst. Min. Engrs. *m.* London.
Travelers Standard. *m.* Hartford.

Werkzeugmaschine. *b-m.* Berlin.
Western Engineering. *m.* San Francisco.

Zeitschr. f. d. gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Ver. deutscher Ing. *w.* Berlin.

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THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. L DECEMBER, 1915 No. 3

How to Sell to Latin-America

By Alex. Del Mar

No country produces superior mechanical goods than the United States, yet our manufacturers have experienced, and still do experience, great difficulty in marketing their goods in South America. Mr. Del Mar from long knowledge of the country and its customs, first, as a mining operator, and second as president of the Latin-American Chamber of Commerce, tells what the difficulties are and how they can be overcome. We are indebted to *American Exporter* for the photographs illustrating this article. —The Editors.

THAT stimulus which Europe in arms has recently afforded to our trade with South America furnishes an exceptional opportunity to still further enlarge it, especially in the engineering line; that being a specialty in which American manufacturers are concededly superior to the rest of the world.

The older and more experienced manufacturers and exporters know how to get this trade, how to enlarge it, and how to retain it. Others effect a favorable opening, but do not succeed in making customers. Goods are all right, but for some reason or other orders are not repeated. Why?

How Not to Get the Trade

Let the exporter imagine, as some exporters do, that because gold is not the current coin, Latin-America is without means to purchase goods; that its merchants are impecunious or of doubtful credit; that they may be invaded with impunity by hustling drummers in broken Spanish, or unceremoniously addressed in written correspondence; and he will probably find that the buyer will decline to continue the connection. In some cases, after obtaining an initial order for goods the exporter does not regard it essential to fill it according to agreement or sample, and considers himself at liberty to vary or deviate from the contract whenever it suits his interest or convenience. Something is substituted.

"Almost any old thing will do." No necessity to pay any special attention to wrapping, covering, dividing, packing, invoicing, etc. No special stipulation having been made on that subject, he feels at liberty to ship his goods to another hemisphere just as he would to this one and to subject them to conditions of marine and inland transport, handling, and

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BAY AND PIER, CARTAGENA, COLOMBIA

vending, to which he is an indifferent stranger. In case of damage or loss by fire, water, lightning, breakage, robbery, custom-house detention, etc., he holds himself entirely irresponsible; and does not deem called upon even to console his correspondent. On the contrary, if he has been so incautious or indulgent as to grant short credits for small amounts to a Latin-American customer of irreproachable character and good local reputation, he deems it the right time to stop the credit and demand a cash settlement. "No trusting those foreigners too far." The following correspondence from official sources furnishes a recent case in point:—

From Special Agent Gerard Harris to the U. S. Department of Commerce: "As has been several times noted, American merchants have yet many little points to learn as to the best way to deal with business houses in Latin-America. Personality plays an important part in business in the

EL PASEO, COLON

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PUBLIC MARKET AND BAY, CARTAGENA, COLOMBIA

countries to the south of us; and manifestations of friendly interest often serve to cement the bonds of business relations. Last May a fire occurred in Colon, Panama, in which many blocks of houses, including many business houses, were burned, with a loss of some millions of dollars. A month or so later, a business man received two letters in the same mail, one from a firm in England and the other from a United States concern. He had been dealing with both firms about the same length of time, and was apparently in the same position of an old and reliable customer with both of them. His rating, moreover, was first class. The English letter was in cordial terms and said in part: 'We have many trading friends in the city of Colon and are anxiously waiting to hear that none of them have suffered from the fire. We realize full well that business cannot be very brisk on the Isthmus and that this fire, coming along at this time, must indeed make matters very awkward for people in the city of Panama. We wish to take the opportunity of expressing our sincere regret at the disaster. Of course, the burdens of the present situation in England are falling heavily on all of us; but we are meeting the situation. Give yourself no occasion for worry at the state of your account. We know how conditions

PORT ON THE MAGDALENA RIVER, BARRANQUILLA, COLOMBIA

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are. Send on your orders, and they will be filled as usual and upon the usual credit terms.' The letter from the American firm was short and ran about as follows: 'Dear Sir, Owing to war conditions, we are compelled to curtail our lines of credit and the terms in future will be, etc.' The terms offered were practically cash. The contrast between these letters was striking, and the difference in the effect they produced on the mind of the merchant receiving them can easily be imagined. It is obvious that American trade with Latin-America will not supplant that of European competitors until such details as these are handled as carefully as they are from Europe."

all the ports and the principal towns of the interior. The writer has inspected a list of 150 Latin-American commissionaires with every reason to believe them well adapted to fulfil the duties assigned to them as reliable middle-men for the prosecution and increase of American trade with the southern hemisphere. They know the local language, laws, people, and customs. Nearly all of them are natives and to the manner born. And this is important. For example, the

PERUVIAN LLAMAS IN A PUBLIC SQUARE
This small beast of burden is still used for transporting material

As a rule, American business letters to Latin-America are couched in the same spirit of coldness, harshness, and cynical indifference exhibited in the above correspondence. "Business is business, etc." The American exporter sometimes even neglects to enclose his communications in suitable envelopes; and not unfrequently dispatches them with a two-cent stamp, as though he thought the United States extended to the South Pole.

COMMISSIONAIRES

Both in seeking trade and pursuing it in Latin-America it is usually of the greatest advantage to employ the commissionaire. He is to be found at

customs regulations of these countries are very minute. Fines or forfeitures are provided for every deviation from the prescribed rules. Omitting to state the nationality of the ship carrying the invoiced goods; the employment of "do" or ditto marks; failure to designate the exact name of the goods; marking cases with brushes instead of stencils; shipping goods "to order;" and many other details give rise to penalties or delay which only the experienced commissionaire will know how to avoid. It is also useful to know that at a certain Latin-American port a proportion of the duties may be paid

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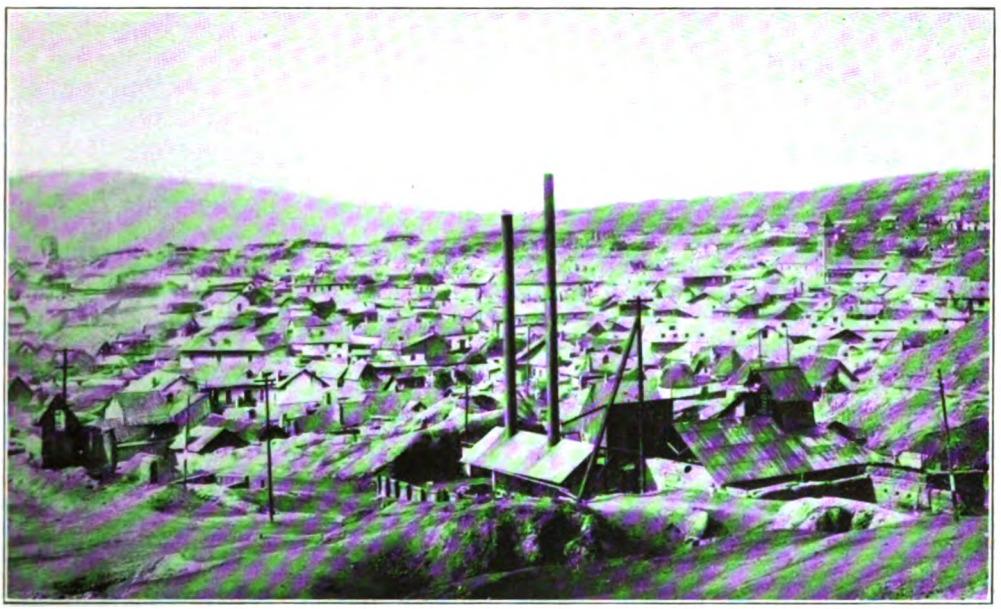
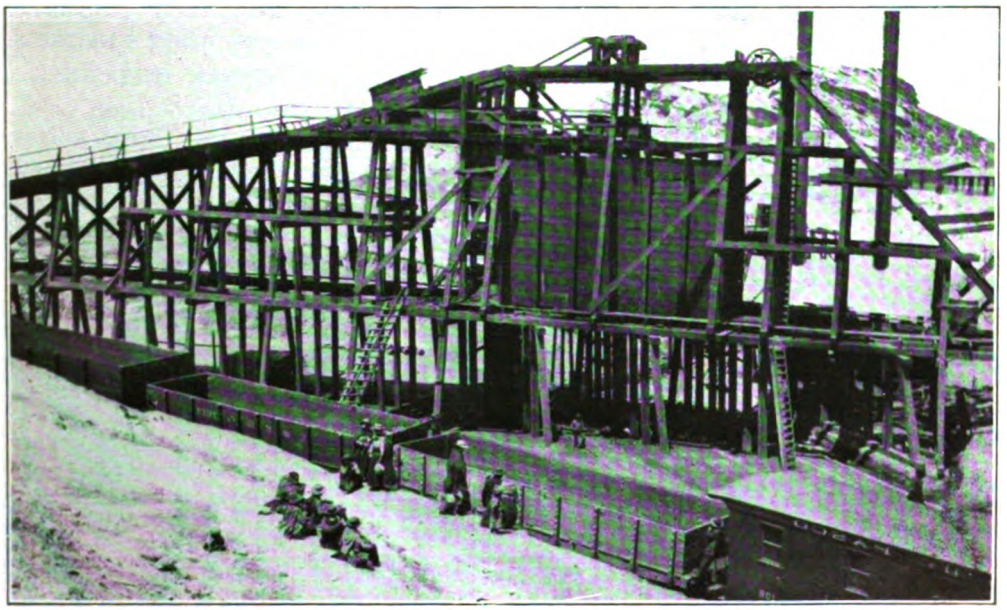


CERRO DE PASCO, PERU

in bonds purchaseable locally at 50 cents to the dollar; that at another Latin-American port duties are payable in a given coin that may be purchased at a discount; and so on.

Except as to the last particular, these regulations and conditions are neither better nor worse than our own custom-house regulations. For example, no importing merchant in New York would omit to employ a custom-house broker. Well, the Latin-Amer-



LOADING STATION AT THE CERRO DE PASCO MINES, PERU

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SHIPPING IN THE HARBOR OF VALPARAISO, CHILE

ican commissionaire is, among other things, a custom-house broker. He is also a negotiator, salesman, buyer, adjudicator, seeker of concessions, in short an indispensable middle-man, whom as a rule it is wisest to employ. Interest makes it so; custom makes it so; and custom is paramount in Latin-America as well as elsewhere.

Said Mr. Geo. M. Reynolds, president of the Continental and Commercial bank of Chicago, in an able address to the Federal Trade Commission, last July:

> Actual contact with the people of Latin-America should be in charge of men who know the language, practices, and customs of those countries.
>
> We (the bankers) have to find credit to enable men to handle the products which we wish to export (and import). Credit can only be extended if business is stable, or rather if the credit is stable and the business is prosperous.

These two sentences admirably cover the principal requirements: First, the proper men employed to seek trade, to bring North and South American merchants into correspondence. Second, a fiscal means by which these correspondents may be enabled to sell or exchange their respective commodities in each other's markets.

Decline of German Influence

Germans have hitherto been somewhat successful in the Latin-American trade, not because their goods are superior or their manners more conciliating than the generality, but rather because the British, who monopolized the entire trade down to the Sixties, grew careless, shipped old-fashioned things to Latin-America, and relied on the friendly influence of their banks at the sea-ports to mollify the buyers. Country stores in the remoter towns of South America were to a recent day stocked with British hardware nearly a century old and, therefore, unsaleable; such as single-barrelled pistols, flint muskets, blunt-pointed screws, hand-made

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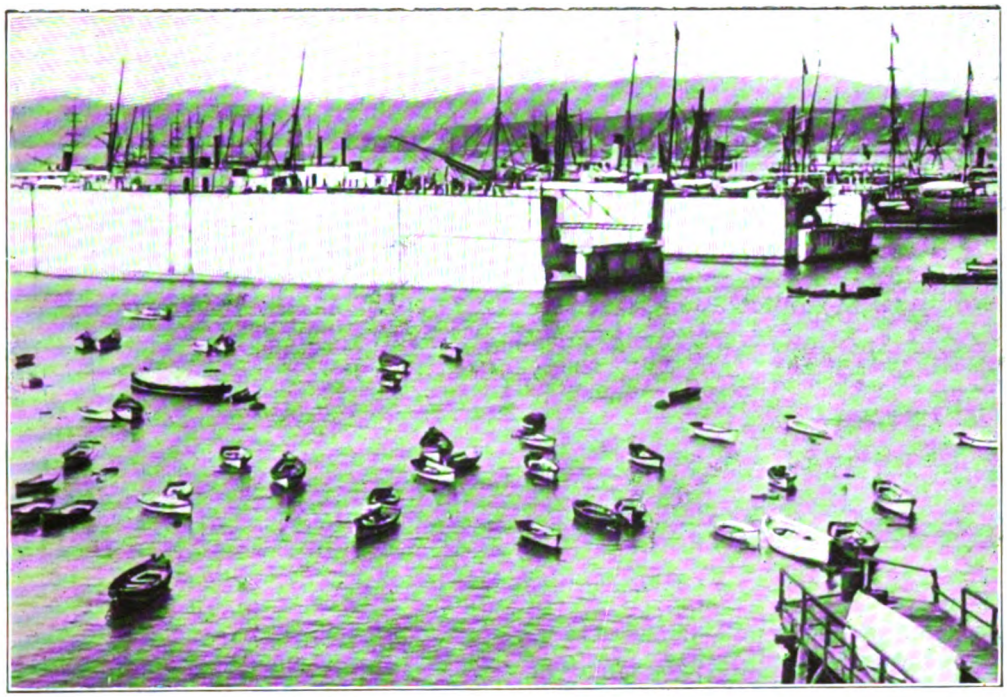
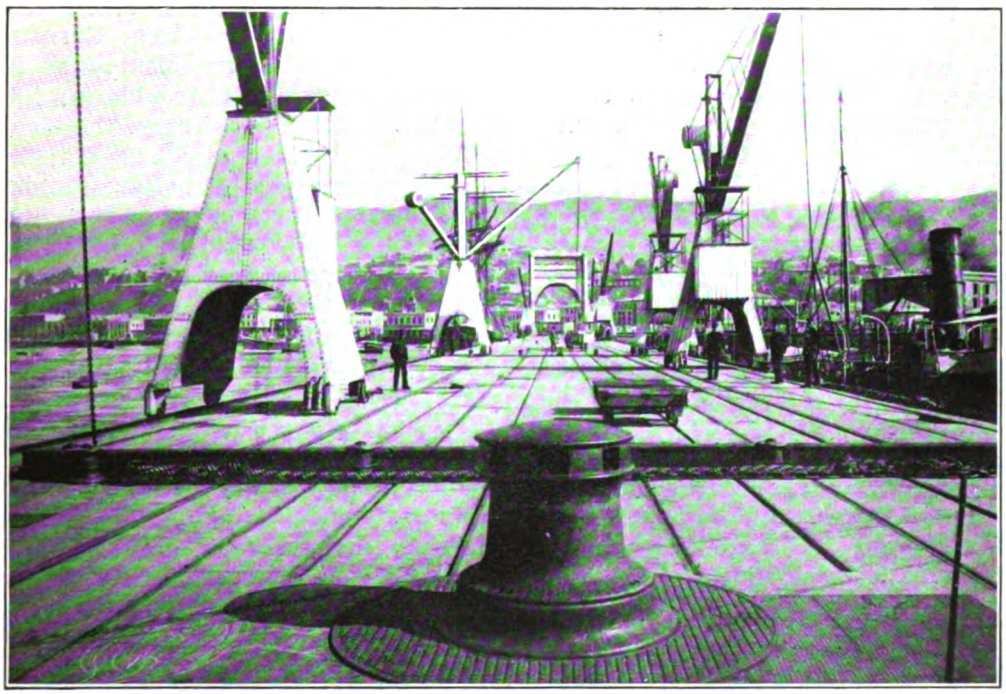


HARBOR AND FLOATING DRY DOCK, VALPARAISO, CHILE



UNLOADING EQUIPMENT AT THE FISCAL PIER, VALPARAISO, CHILE

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STREET IN LA PLATA, ARGENTINA

nails, unlined iron pots, obsolete brass things, two-pronged table forks, and other dumpage. The Germans had no difficulty in capturing a fortress so negligently guarded. They sent educated and courteous canvassers, salesmen and commissionaires conversant by long practice with the languages of Spain and Portugal, and capable of acquiring that local information which forms the basis of credit. They knew the history of Spain and Portugal, in turn two of the foremost nations of the world, proud of their achievements in arms, commerce, and literature; and being well aware of the influence of these memories upon the Iberian colonists of Latin-America, they made shrewd use of their advantage. But the day of German ascendancy in Latin-America is gone. Prussian veneer has succumbed to the soft trade winds of the South Atlantic, and old France and Spain on the one side, with old Japan on the other, are seeking, with the prestige of courteous manners, united to modern business methods and modern commodities, the neglected trade of the southern hemisphere.

An intelligent and observant writer, with some personal experience in South America, has recently expressed the opinion that, "Any extensive program for the expansion of American trade in Latin-American countries which leaves German competition out of its calculations, is piling up superfluous trouble for the future." On the contrary, the Germans will find their places filled, their goods superseded by better brands, and their credits forestalled in South America. The world will not have stood still during their belligerent invasions of France and Belgium. The British, with the advantages of steam lines to every Latin-American country, British banks at all the ports, British railways to the interior and British concessions on long leases, will take the lion's share; the French, with dress goods, linen, *bijouterie*, jewelry, and works of art will offer the most attractive markets to South Americans, while their Bordeaux line of packets will continue to afford the quickest and most luxurious means of travel to and from Europe.

Even old Spain is energetically bid-

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BAHIA, BRAZIL

ding for the trade. Says U. S. Consul-general Hurst (C. R. Supp, Sept. 2, 1915):

Much has been done in Spain to draw closer the ties connecting it with those trans-Atlantic republics wherein Spanish is the prevailing language. Political, commercial, historical, and literary associations have cultivated a union in sentiment, with a tendency to develop more intensive trade relations, between the mother country and her former colonies. This trade is steadily growing; and the $111,000,000 worth of commodities representing the business done in 1913 (latest figures) represents an increase of $15,000,000 over the previous year. It is asserted that if the trade between Spain and the Latin-American republics continues in like proportions, the annual volume will (soon) exceed $180,000,000. There is every reason to believe that this trade will be increased on account of the War, as the business heretofore done by certain European nations in South America has practically ceased.

PORTUGUESE FISH VENDER, BRAZIL

The United States has its own special rôle in this peaceful and honorable rivalry for trade—a rôle that especially interests the engineering world, because it consists largely of steam and electrical machinery, motors, automobiles, and other mechanical devices in whose manufacture and improvement we enjoy a superiority which no other nation can wrest from us. The amplitude of our agricultural industries affords us another specialty which must for many years yet to come command a large share of the Latin-American trade. For the present it is chiefly a question of how best to secure it.

Said Dr. Bernard Dernburg, upon

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RIO DE JANEIRO, BRAZIL

his election as President of the German Economical Association, September 1, 1915: "Only too often the German exporter has shown a lack of friendly disposition toward merchants abroad; a matter of special weight with the Southern peoples." On the very same day a Japanese Commercial Exposition was opened in Santiago, Chile, under a committee selected by the President of the Republic, which at once became popular, owing to the variety, novelty, and beauty of the commodities represented, the politeness of the exhibitors, and the convenient terms of payment stipulated for sales and consignments.

Because of its deficiency of coal and iron, Dr. Dernburg thought that South America would always be dependent upon manufacturing States; but here he is probably mistaken. South America possesses practicable sources of mechanical power which but a few years ago were unsuspected, but now are quite within engineering grasp. She has numerous rivers and cataracts, with ample and continuous fall of water for electrical machinery; and rich metallic and mineral fields to work up. Thousands of profitable enterprises, with capitals of say from $100,000 to $200,000, can be established at once by those who know the country, the people, and the routine of lawfully securing advantages in the various States of Latin-America.

Concessions — Customs Regulations — Labor

An instance of this kind, which some years ago occurred to the writer, an engineer by profession, may serve to make this clearer. Having been commissioned by a London company to "locate" or acquire certain mines in Brazil, and knowing the people, the laws, and the routine, he succeeded in doing this without any other expense than the lawful official fees of registration. The title to work the con-

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THE AVENIDA RIO BRANCO, RIO DE JANEIRO, BRAZIL

cession having been duly registered, he purchased the necessary machinery in England and shipped it in parts by several successive steamers to Rio. Upon its arrival there it was assessed by the Customs authorities under various heads of "hardware," subject to duties varying from 45 to 70 per cent ad valorem, rates which his local attorneys saw no means of avoiding, or any remedy for, under the Statute laws. Such was the situation upon his own arrival at the port. Familiarity with Brazilian treasury regulations fortunately suggested an amelioration. They contained a provision, but little known or noticed, which enabled any "novel machine" to be imported free of duty. Employing the language of this provision, and referring to it in his invoices and customs-entries, he succeeded in passing free of duty the entire lot of "hardware" as one "novel machine" in parts; which it really was. After starting the mining works with water-power and native labor, the latter at a vintem (20 cents) a day, and proving the productiveness and profitable character of the works, they were sold by the owners to native proprietors, who have continued to work them with success down to the present time. The entire capital actually employed in this transaction was less than

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A BUSY CORNER IN A BRAZILIAN CITY

$100,000; the profit was nearly $150,000; the time expended was little more than a year.

Profitable trade with South America should not consist in merely seeking orders for commodities which the manufacturer, contractor, or merchant has to sell, but also in establishing enterprises for which the natural resources of that vast continent are advantageously adapted, and which its people require for their further development and progress. It was the same with the United States in the Fifties. At that period Birmingham, Sheffield, and Manchester supplied us with nearly everything we required in the shape of manufactures; and had the British sought no other employment in America for their capital, it would have long since retired from a discouraging and dwindling foundation. But they invested in American railroads and manufactories, and, during the Civil War, in American bonds, National bank shares, and other enterprises; with results that, in spite of some blunders, proved to be much more profitable to the lender than the borrower. Yet the exhilarating effect upon the latter, aided by the great natural resources of our country, has been so great that now our British friends have come as borrowers, who formerly came only to lend.

South America wants sellers, but she still more urgently wants buyers, not alone for the valuable commodities which she produces with slow, ill-requited and dissatisfied labor, but buyers also for those illimitable resources with which Nature has lavishly endowed her: her arable lands, her lakes, rivers, water-powers, mines, forests, pastures, and fisheries. At the present time the United States overflows with gold, which her bankers will probably be asked to invest in European bonds: South America has no gold, but needs it pressingly for coinage and can offer for it pro-

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THE CAPITOL BUILDING, CARACAS, VENEZUELA

ductive estates, which, in a few years are capable of returning (as North American investments have returned to England and France) manifold profits and political friendships; the latter based on the secure foundation of mutual interest, and therefore likely to prove as fruitful as they have proved in our case.

Steamship Facilities

One of the principal handicaps in our export trade to South America is the lack of quick steam communication. There are British, French, Spanish, Italian, and even Scandinavian steamship lines to South America, but no American lines; not a single one. The reason of this is that, at the higher level of prices for ships' stores and for seamens' wages which prevails in the United States, no ship flying the American flag can successfully compete, either in freights or fares, with an European or Asiatic ship. This has been the case for nearly 60 years, and as things stand it is likely to prevail for another 60 years. There is no remedy for it, short of revising that entire code of fiscal, economical, and emigration laws upon which the American level of prices is based; a revision that is not at all likely to be attempted. This was shown very conclusively in an official report on "Ship-building in the United States," made to Secretary McCulloch some forty years ago. No change in conditions having taken place in the meanwhile, the official conclusion remains as apt now as it was then. When coal and steam superseded sails, when they converted the sailor into a coal-heaver and dish-washer, when they substituted fresh provisions for salt junk and sea biscuits, the supremacy of the United States in the carrying trade was lost. The Confederate privateers only completed a ruin which had begun many years before.

Our Government officials, somewhat slow to recognize the signifi-

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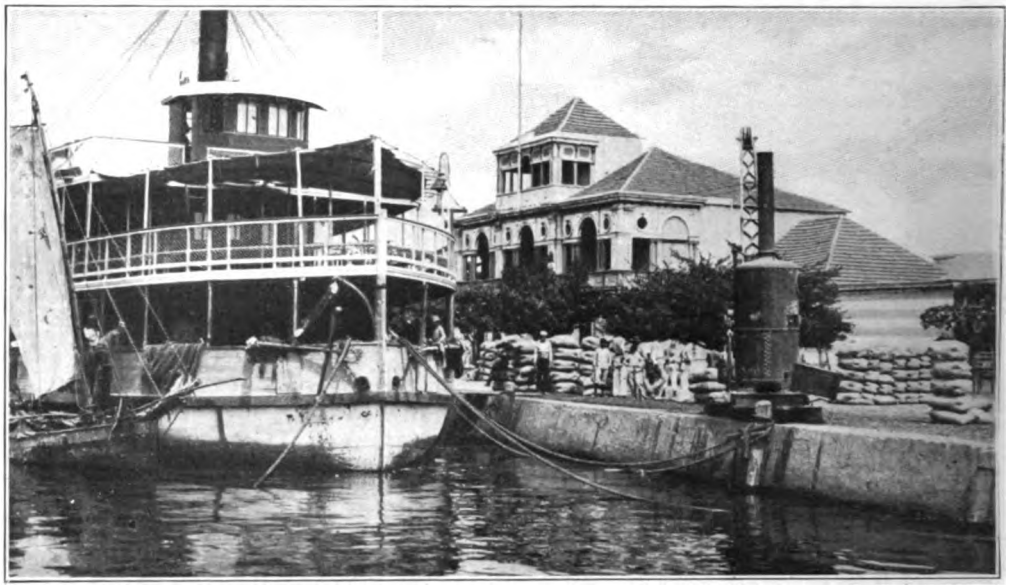
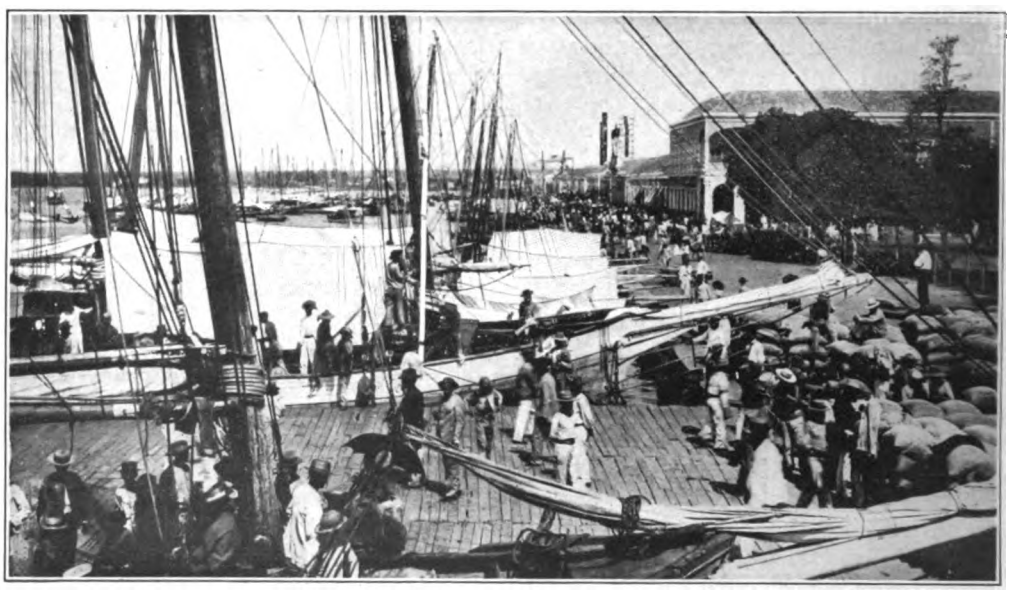


CUSTOM HOUSE AND LAKE STEAMER, MARACAIBO, VENEZUELA

cance of these circumstances, yet anxious to find such a remedy for them as will at least better our maritime commerce with South America, have on several occasions recommended a subsidized steamship line to that neglected part of the world; but no sooner is such a project mooted than up jumps some *atravesado* to warn the President in the most solemn terms not to entertain it, on his (political) life. Yet it remains the only practical remedy*; and if not

* See editorial comment, page 437.



A QUAY SCENE IN MARACAIBO

Bags of coffee brought from the interior are conspicuous. In the distance at the right are ranged the hardware, shipchandlery, and provision houses.

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FISHING VESSELS FROM LAKE MARACAIBO, VENEZUELA

adopted, it will continue to be easier to reach Rio Janeiro from New York by way of London, Paris, Bordeaux, Lisbon, and Senegambia, than to attempt it direct in a tramp steamer. Not only this, but as the Brazilian and Argentine merchant can replenish his stock of goods from Paris in 14, Barcelona in 16, or London in 20 days, while from New York it takes 26, his orders will continue to be cabled to those nearer and more ac-

NATIVES OF MARACAIBO

A hundred miles back from the city of Maracaibo begin the forests still untrod by white men, their fastnesses defended by Indians. Two American engineers lately narrowly escaped capture and death at their hands.

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cessible markets, where *atravesados* are not permitted to clog the wheels of commercial progress.

One of our leading instructors in "How to Achieve Success in the Latin-American Trade" thus lightly gives forth in the columns of the metropolitan press:

"All that the American salesman lacks is specific information and preparation, and these can be readily acquired by any intelligent salesman who makes up his mind that it is worth while. In three months he can learn passable Spanish, and Portugese in four; while a very fair knowledge of the distinctive requirements of the various markets and their respective trade statistics can be acquired from publications easily accessible. Once convinced that these markets are of value and their attention given to details of development, our men can be safely trusted to do their part."

Spanish in three months; Portuguese in four; distinctive requirements and trade statistics easily accessible! *C'est pour rire.*

CAPITAL

But seriously, such an equipment, apart from its grotesque character, does not touch the case at all. What Latin-America lacks most urgently is not merchandise, but money; not cargoes, but capital to buy them.

Says our far better informed Consul in Cartagena: "The one greatest drawback to the progress of Colombia is the lack of capital. Money is scarce and earns 12 to 24 per cent annually. The average interest may be placed at 18 per cent annually. At less than this, local investors are loth to lend." Again he says (and this is the special point as to trade): "It is quite natural to expect that the country loaning the money will capture the contracts. . . . The coffee crop was financed in Germany; the famous emeralds of Bogotá are marketed through a British syndicate; many railways are owned by the British. The mines have been developed by American and British capital; the banana industry is American." Similar conditions exist in many other States of Latin-America. Some could be mentioned that are practically governed (and perhaps periodically revolutionized) in London or Berlin. Apples are not to be shaken off such trees by hailing them in school-boy Spanish, or by consulting the trade statistics of countries that levy both import and export duties, and whose statistics therefore are notoriously antiquated and misleading.

At their last annual meeting the Buenos Aires Chamber of Commerce reported that there was "no danger of an American commercial invasion of South America, because the Americans do not know the market, lack men sufficiently familiar with the Spanish language and the customs of the country, and moreover possess no ships. The British have all these advantages. United States merchants can hardly expect British ships to carry American goods to South American markets, so long as there is British freight offering."

The Peruvian Corporation, a British company established 1890, owns or operates under long leases from the Peruvian Government 75 per cent of the railroads of the country; practically controls the exportation of guano; owns and operates the principal steamers on Lake Titicaca; and conducts what is known as the Perene Colony on the eastern slope of the Andes, where coffee, fruits and other agricultural products are raised for both local and foreign consumption. In payment of Peruvian bonds held by the shareholders in London it obtained two million tons of guano for export, nearly all of which has already been sent out of the country. (Report of Consul-General Handley, Callao-Lima, July 27, 1915.) Such are some of the results of foreign capital judiciously invested in Latin-America.

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UNDER-ADVERTISING OF THE STEEL BUSINESS

By George H. Jones

Vice-President and General Manager of Sales, Inland Steel Company, Chicago.

Mr. E. St. Elmo Lewis, who has distinguished himself in the science of publicity, is under engagement to prepare a paper for our pages on "Publicity in the Engineering Field," and he has been asked to write it because the minds of our American manufacturers, and especially American machinery builders, are so intent upon problems of production, that only very few of them ever made any study of the science and selling value of publicity. We had planned to present Mr. Lewis' paper in this number, but unfortunately his many pressing engagements have rendered it impossible for him to prepare the manuscript in time.

Very fortunately, however, we are able to present in its place a paper upon the same subject which is certain to make a profound impression—especially because it is written from the viewpoint of the manufacturer.

During the past seven or eight years Mr. George H. Jones has been making an intent study of the problem of intelligent and effective publicity for the iron and steel industries, and he finally embodied his conclusions in the form of an address delivered at the recent meeting of The American Iron and Steel Institute in Chicago. Through the courtesy of Mr. Jones, and also the Editors of the Journal of the Institute, we are privileged to present the address in full, and we warmly commend its careful perusal to our readers.—THE EDITORS.

ENGLAND has raised the greater part of an army of four millions by advertising, using newspapers, billboards, omnibuses and other methods. This was considered the most effective way and its application is almost universal.

This is an object lesson to the iron and steel manufacturers who have been in the habit of saying about advertising, "When the demand for our products is good there is no need for it, and when the demand is poor there is no use of it."

The steel manufacturers can pave the way to make depressions less severe by stimulating a demand for the products of the steel mills. The way many of us advertise is to place what amounts to a business card in a trade paper and let it go at that. It will do once in a while to call attention to a full list of our products, but it possesses little sales value. We want our advertisements to be read. We must, therefore, give truthful information of value to a prospective customer, and whenever possible the matter should be well illustrated. One product only should be treated in one advertisement. Sizes, quality, capacity and other special advantages we have to offer should be stated and enlarged upon. We should answer the readers' questions before they are asked.

ADVERTISING AGENCIES

Very few of those who have advertising in charge have the time or inclination to do this work properly. It requires much watchful detail work, knowledge of the printer's art and getting the copy to the publication at the proper time and *ready* for printing. An advertising agency can do this well at a comparatively small cost and it brings in a trained mind and

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another viewpoint. When you consider what you pay annually to the publications in which you advertise and the aggregate of all, it is worth the small extra percentage which it costs to have much of the work done by an expert. This cannot be entrusted to the publications themselves, who offer to do it without charge. With the best intentions, they cannot solve the problems of their advertisers, nor do they have the necessary technical or other knowledge to do it. Their methods are more or less stereotyped and lack the knowledge to carry conviction. The practice of accepting this free copy service from newspapers has the added disadvantage of destroying all unity in the campaign.

Trade and technical periodicals must not be neglected in making out an advertising program. A certain amount of general publicity is also necessary, and the public must be informed of the merits of any special product, in order that a demand be created for it, without which the dealer and manufacturer would not ask for it. Pamphlets, booklets, folders, cards, circulars and letters can be successfully used. The personal call is often necessary and the outdoor field could be used to advantage. Catalogues that give some real information and explanations are badly needed. Too often they only represent the mill man's viewpoint and give the buyer very little of the facts and figures he needs. Catalogues are recommended to be of uniform size—$8\frac{1}{2} \times 11$ inches, and preferably issued in separate divisions covering kindred products.

Creating Demand for Steel Products

The use of structural steel is due to a demand for it rather than to any effort made by the steel manufacturers to introduce its use. But steel bars for reinforcing concrete are required in the main as a substitute for other than steel construction because the cement manufacturers and the concerns controlling patented bars promoted a large use for their products and in doing so these bars came into being, in spite of rather than because of the steel makers themselves. The tonnage of concrete bars now made by steel manufacturers is of considerable importance to the industry.

At the May meeting of the Institute Mr. Edward M. Hagar said:

> If the manufacturers of steel spent as much money to instruct the people in new uses for steel as the manufacturers of cement in proportion to the dollars of business done, the steel men would be spending $12,000,000 a year to extend the uses of their own product. That $12,000,000 would represent only a fraction of a cent of each dollar's worth of business done. We cement manufacturers have found by experience that we get back with big interest all the money we spent in this educational campaign.
>
> The cement manufacturers are helping the steel manufacturers in this direction. Reinforced concrete calls for steel rods. Iron and steel producers and the cement manufacturers might find it mutually advantageous to co-operate in this educational work.

The Association of Sheet & Tin Plate Manufacturers last year started a Bureau of Development which promised well, but it did not materialize owing to the "penny-wise and pound-foolish" ideas of many of those to whom it should have appealed and who were invited to co-operate. Enough subscriptions were not received to justify them in going ahead with the very full and comprehensive program outlined in their "Memorandum of Plans." In this pamphlet Elbert Hubbard is quoted as having written:

> Not long ago I visited a State Hospital for the Insane.
>
> Walking over the beautiful grounds half a mile from the main building I came across an attendant in charge of twenty-five patients.

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The attendant was a little man, a sort of half portion. Many of the patients weighed twice as much as he.

I walked along with him for some distance and in the course of our conversation I said: "I don't want your job. What is to hinder half a dozen of these big fellows getting together and setting up a job on you? If they would get at you all at once you would not stand any show at all. There is no help within half a mile and you are not armed."

He looked at me in rebuke and remarked: "You belong here, all right! You ask what is to hinder these fellows getting together and setting up a job on me? Why, the fact is, if they could get together with anybody or anything they would not be here. That is their trouble. Nobody is ever sent to an insane asylum who can do team work."

The badge of sanity is the ability to cooperate with other people; and the more people you can work with and for, the bigger and better you are. It is an age of organization.

Competition may have been the life of trade once, but it is no longer so. Competition died when the inventive genius of American engineers devised machines that should manufacture beyond the present economic wants of the people. Competition then became suicidal and destructive, and anything that is suicidal is dying—dead.

Simply because one is in the same line of business as another man is no reason why he should attempt to destroy him. A certain amount of mutuality is absolutely necessary to live.

Elbert Hubbard was not a steel man, but he was, nevertheless, about right with regard to the lack of cooperation in promoting the steel business.

Example Set by Lumbermen

About six years ago five men in the South each put up $260 into a fund to advertise red gum in an architectural journal, after dint of much hard work on the part of a representative of that journal.

Though they were men of wealth, this $260 came hard because they really did not believe that anything would come of it.

But the result of that $1,300 venture was the sale of red gum aggregating $350,000 with three successive $2 jumps in price per 1,000 feet in a single year. This campaign has continued year after year, as high as $40,000 a year being spent in it. The result is the widespread use of red gum wood for fancy interior finish—a wood that had previously been in the railroad tie class.

This campaign started the Southern Cypress Association into action, and their annual advertising expenditure far exceeds that of the Red Gum Association.

Then came the North Carolina Pine Association, the Northern Pine Association, the West Coast Lumber Manufacturers Association, the California Redwood Association and, last and largest of all, the Southern Yellow Pine Association. There is now talk of an amalgamation between all their interests for the purpose of financing a mammoth campaign in favor of wood as against "substitutes" for wood.

Let us acknowledge that, as a class, the steel industries of the country are the most clumsily and inadequately advertised of all our industries.

I almost feel safe in saying that more advertising money has been spent in *tooth paste* than all of us combined have expended in all of our products.

And our total expenditure would look like small change beside the bank roll expended annually by the chewing-gum profession, the soap artists or the baking powder family.

Yet steel products as a group are just as susceptible to the power of publicity as any of these; because just as universal in consumption and vastly more important to the public welfare.

Result of Advertising Hawaiian Pineapples

Up to 1909 the importation of pineapples from the Sandwich Islands was so inconsiderate that they were not even listed in the government reports.

But about that time thirteen lead-

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ing producers formed an association and placed in the hands of Mr. Dole, son of a former president of the islands, about $100,000 with which to educate the American people to ask for Hawaiian pineapples.

Successive reports show the following importations:

Exports from Honolulu—canned pineappples and pineappple juice:—

1910.....	$1,558,507
1911.....	2,244,931
1912.....	2,704,446
1913.....	3,644,794

The point is that that intelligent campaign carried on year by year not merely diverted the trade away from Cuban and Bahaman pines, but it multiplied the *total consumption* of pineapple products to a degree not even faintly hoped for by the Hawaiian growers and canners.

NEW FIELDS FOR STEEL PRODUCTS

Similarly, an educational campaign on steel products will not only serve to protect us against the onslaughts against us made by various substitute products, but it will lead to a great total increase in building operations. Just one case in point: A million farmers now leave their implements out in the fields all winter unprotected by *any* shelter—steel, wood, paper, or otherwise. Our duty to ourselves and to the farmers is to stop this ruinous loss by first showing them their folly, and then giving them practical instruction in the way of stopping that loss by erecting sheet steel shelters.

Another instance: Cash wheat at harvest time averages some cents per bushel lower than its selling price in mid-winter or early spring. This is simply because farmers, with no place to store their wheat, sell it to the local elevators at whatever price they offer. Our duty is to show the farmers how they can vastly increase their earnings by erecting inexpensive steel grain houses and storing their grain on their own farms until demand has caught up with the supply.

Still another typical example: Shelters at cross-road stops of interurban trolley lines. The right sort of an educational campaign will show these roads how they can increase their traffic by providing this comfort; and if they don't do so, such a campaign will wake up the farming public to demanding it.

No doubt hundreds of other fields lie open to us if we will but learn the vital necessity of harnessing the vast willing and responsive power of educational publicity. The same sort of organized publicity has been done with other products, among which may be mentioned electrical machinery and equipment, gas making machinery, etc.

FIRE PREVENTION

The Association of Sheet & Tin Plate Manufacturers in April, 1914, issued a pamphlet entitled "A Discussion of Fire Prevention in Its Bearing Upon the Use of Non-Inflammable Materials." I quote a few pertinent paragraphs:

> Nobody can deny that if all buildings were made absolutely fireproof and everybody continually careful, we might save most of this stupendous amount of wealth now wasted annually.
>
> It is a worn out fallacy which assumes that the fire loss is borne by the insurance companies. They bear no loss but act merely as collectors and disbursers. The losses are a tax on every man.
>
> The cost of maintaining fire departments in European cities is about 25 cents per capita per annum, while in American cities it is $2.57 or 10 to 1, and the cost of fire loss and fire fighting combined averages in European cities 58 cents per capita per annum, while simultaneously in America it costs $5.07 or at the ratio of 8¾ to 1. This difference is due almost entirely to better building conditions.
>
> It has been estimated by the underwriters that 27 per cent of the fire loss in this country comes from fires that extend beyond the buildings in which they originate.
>
> A reasonable conclusion is that losses are due to the inflammable construction of our buildings.

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Another writer states the loss by fire in some of the older European countries is only 2 cents per capita and in the United States $2.80 per capita or 140 times as much.

It is reported there are six million farms in the United States, 10 per cent of which use metal roofing and 30 per cent patented (not metal), and the remainder generally shingles, with perhaps a few tile and slate roofs. This condition can be changed by proper promotion work and patented roofing largely supplemented by sheet steel and tin. Some good work has been done along these lines, but not enough to make much of an impression. The question of fire and lightning comes in here. The perils of combustible roofs are well known, but often forgotten. They should constantly be kept before the owners of farm and other buildings.

The manufacturers of patented roofings, more or less inflammable, spend large sums annually running into the hundreds of thousands of dollars in advertising their goods and have been successful in getting them used, to our disadvantage.

Advertising has made the use of patented roofs possible and the mail order houses have been liberal and consistent helpers. These feltless "felt" and rubberless "rubber," inflammable, "fireproof" roofs have very little excuse for existence besides encroaching largely into the percentage of shingles, and metal roofing should take their place.

The National Hardware Association this year offered prizes for the best essays on "What Constitutes a Good Roof," from the standpoint of metal roofing. The three best essays have been printed in a booklet which is given a large circulation. This is a step in the right direction.

One phase in the extension of the sale of many of our products is the education of both wholesale and retail merchants, especially the retailers and their clerks.

By making them better steel salesmen we can multiply their sales. This is of vast importance because the aggregate tonnage of steel and steel articles sold to the consuming public through retail sources is exceedingly great.

Lumber dealers are now selling steel fencing, steel fence posts and steel roofing. It is not natural for them to do this, but they are merchants first and lumber dealers afterward. They are, therefore, selling what is asked for, and we can help them materially to increase their sales of our products. Modern saw-mills, interested only in the production of lumber in its various forms, are using steel roofing and in doing so they admit it has advantages over their own product. It is fireproof, lightning-proof when properly grounded, and will last longer when taken care of than any of the materials heretofore used.

FIELD FOR PROMOTION OF STEEL SALES

Promotion and sales work—comprehensive and extensive—is needed to further the use of steel in the following directions:

Roofing and siding of proper weight in place of patented materials.

Fence posts for railroads, farms, vineyards, and other uses. There are, probably fifteen to twenty concerns now making steel fence posts and they are commencing to do well, but the possibilities in this line have hardly been touched upon.

In bolts—on account of the greater tensile strength and uniformity of structure.

In many lines of work steel has come into its own and may be safely left as it is, but steel could be used in smaller sizes, giving equal strength and less weight, in the following items among others:

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Metal Shingles
Metal Ceilings
Steel Lath
Steel Fire Doors
Steel Window Frames
Steel Lockers
Steel Culverts
Steel School Furniture
Steel Office Furniture
Steel Shelving
Steel Barrels
Steel Kegs
Steel Crates
Steel Packing Boxes
Steel Telegraph Poles
Steel Telephone Poles
Steel Railroad Ties
Steel Cattle Guards
Steel Wagon Bodies and Seats
Steel Wagon Tongues
Steel Double Trees and Single Trees
Steel Hay Racks
Steel Barns
Steel Hog Houses
Steel Chicken Houses
Steel Implement Sheds
Steel Grain Bins
Steel Corn Cribs
Steel Fruit Picking Stands
Steel Ladders
Steel Scaffolding
Steel Warehouses
Steel Warehouse Boxes
Steel Boat Houses
Steel Storage Buildings
Steel Shops
Steel Tool Houses
Steel Foundries
Steel Repair Shops
Steel Section Houses
Steel Oil Houses
Steel Gasoline Depots
Steel Garages
Steel Real Eestate Offices
Steel Labor Dormitories
Steel Sectional Buildings for factory extensions, and other purposes
Steel corrugated sheets for tight fences
Steel frame work for small buildings
Steel Tanks
Steel Silos
Steel Boats
Steel Barges
Steel Burial Caskets
Steel frames and boards for standing signs
Steel for mine, timbering and tipple work for main and outbuildings

Co-operation of Steel Men in Promoting the Use of Steel

Development work covering an increase in the use of steel in the various directions in which it could be employed to advantage, might be well undertaken by all steel manufacturers and through them by their customers under the direction of a Bureau of Publicity and Promotion of the American Iron and Steel Institute. This Bureau, acting for the interests of the steel business at large and not handicapped by being confined to the product of any one concern, would be on the watch to determine in what way steel could be substituted for other materials and be prepared to offer suggestions as to the best means to secure the results aimed at. The Institute being recognized as a responsible and authentic institution, could not afford to disseminate inaccurate or unreliable information, nor would it be suspected of doing so. It would be incumbent upon the steel manufacturers to carry out the standards recommended by the Institute and not cater to the demand for underweight and cheapened material.

A series of handbooks on steel and its advantages, issued in sufficient quantities, under the auspices of the Institute and sold to its members at cost, for their distribution to the merchants with whom they deal would be most effective.

These might take the form of little pocket manuals such as were issued by the Cypress Association—a manual for each of some twenty general classes of building, structures, or articles. Indeed this plan could be carried still further, the dealer being supplied with a sufficient quantity for him to distribute to his consumer customers, as has been done so effectively by the cement makers.

The booklets would be couched in very simple, non-technical language, with easily understood diagrams and illustrations.

The farms of this country offer a vast undeveloped market for a great variety of steel products. A concerted campaign by this Institute, in the in-

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fluential farm journals, would bring very satisfactory results. This campaign might take the form of offering to the farmers their choice of booklets on certain farm buildings, as for instance silos, implement sheds, roofs, etc.

Such a campaign would involve the expenditure of a large sum in the aggregate, but the share of each member participating would not be burdensome.

I have made no mention of the possibilities in the export business, the exploiting of which is in a class by itself and should be treated separately by one experienced in that particular work.

THE EIGHT-HOUR DAY

By C. J. Morrison

Manufacturers today are confronted with the dilemma of cutting their working day to an eight-hour basis and still producing goods in the same quantity and at the same cost. Mr. Morrison not only thinks this possible but proves that more goods can be made and at lower costs.—THE EDITORS.

THE question as to the length of the working day is before the manufacturer and the public as never before, and in such strength that it demands a solution. Labor wants eight hours, but unfortunately many employers cannot see that their best interests will be served by operating their plants on an eight-hour basis. Some wise employers adopted the eight-hour day long ago of their own accord; others were forced to the decision by the demands of labor; while still others are resisting and stoutly maintaining a longer day.

Those who are working a ten-hour day seem able to see in the eight-hour plan only increased costs, both as to labor and burden charges. They seem to overlook the fact entirely that the work accomplished and not the time spent in the shop is the factor which determines costs.

The case of one manufacturer, which is typical of many, may be cited. His plant was operating on a ten-hour basis; he was shown conclusively that the employees were not working over eight hours, that they started late, quit early, and were idle for considerable periods during the day, and he was urged to put the plant on an eight-hour basis. However, he replied, "We prefer to operate ten hours and let the men take it easy." Now that is not what the men want. They want an eight-hour day and are willing to work energetically for eight hours. Very few men are shirkers and most of the so-called loafing is occasioned by conditions in a plant, not by laziness on the part of the employees.

One of the strongest unions in the country, all of whose members work on an eight-hour basis, has laid down rules for its members which require them to give eight hours of actual work. The rules stipulate that the men must be in their working clothes at their assigned places for work *before* time for starting work, and must not leave their places, clean up or remove their working clothes until *after* time for quitting work. Moreover, each shop has a representative of the union who sees to it that the rules are

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obeyed. Whether or not the men work during the eight hours is up to the management.

Of course if a plant simply changes from ten hours to eight and operates under rule of thumb methods, costs will be increased. On the other hand if the work is properly planned and despatched so that each worker always has a job and the necessary tools for performing the work, the costs can actually be reduced.

To show that the costs can be reduced when a change is made to a shorter working day, the experience of three large concerns may be cited. These concerns operate in entirely different lines and among them employ a very diversified line of labor. In fact all the well known trades are represented.

One of these concerns, a very large printing plant doing practically every line of printing, decided several years ago to change from a ten-hour day to one of eight hours. As competition in most of their work was very keen, the change could not be made unless costs could at least be kept from increasing.

The situation was studied for many months, and as leaks and wastes were found, measures to stop them were put in effect. Problems of power, light, heat, humidity, handling of materials, etc., were studied and conditions improved. Adequate methods of planning and despatching the work were installed, with the result that delivery dates were met and idleness in the plant reduced to a minimum. Finally, the eight-hour day was inaugurated amid great rejoicing on the part of the employees. In fact, the good feeling engendered was so deep rooted that it is still very much alive in the plant.

The company also has had every reason to rejoice, as costs were materially reduced and profits were increased. This is shown by the fact that the stock has greatly increased in price due to the higher dividends paid.

Since then most printing plants have been forced to an eight-hour basis and many have lost money. In fact, a number have gone into bankruptcy.

The second plant in consideration is a large concern with over 5,000 employees which does partly commercial and partly government work. At the time when the law was passed restricting work on government contracts to eight hours per day, this plant was operating on a ten-hour basis with the work divided about equally between the commercial and the government contracts. All of the contracts had been taken on estimates made up on a ten-hour basis. As the law made no provision for increasing the price on government work and prices on commercial work could not be increased, the outlook was gloomy. Of course the commercial work could be continued on a ten-hour basis, but the company decided to throw the entire plant on eight hours and take the consequences.

Very much the same plans were followed as outlined above in the case of the printing plant. The consequences were very satisfactory. Every contract came out *under* the estimates, and during the past lean years the plant has been operating at full capacity due to its ability to underbid competitors.

A nearby competitor, operating under nearly the same conditions of commercial and government work, continued the commercial work on ten hours while working only eight hours on government contracts. They made no special preparations to meet the new conditions, but continued under the rule of thumb methods with the result that they lost money and

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were recently taken over by their financial backers.

The third concern makes a household article, which is extensively advertised and is well known throughout the United States and, to some extent, abroad. Their product requires a continuous operation of the plant, and they were working two shifts of eleven and thirteen hours, respectively. Every other plant in their line operates under these conditions, but they decided to run three shifts of eight hours each. Extensive preparations were made, as in the other cases, but with the exception that plans were made for a continuous production at a uniform rate regardless of the seasonable fluctuations in the sales. This meant that the production exceeded the sales in some seasons while falling short of the sales in other seasons. However, the plan gave the great advantage of steady employment and of running at the same rate throughout the entire year.

The employees were taken into the confidence of the manager and shown where the reduced hours would mean changes in their duties which upset all the traditions of the trade. With the exception of a single employee they replied that they did not care a hang for the traditions, but did want eight hours. This exceptional employee is working in another plant under the old conditions while his more tractable companions are working the three shift plan for the old firm. Incidentally this plant has about the happiest set of employees to be found anywhere.

As in the other cases, the costs came out below the former figures, and this year the concern is giving the consumer more for his money. The sale price has been fixed for many years and it was not deemed advisable to make a reduction.

In the meantime competitors are facing the larger package and an ever increasing demand for the eight-hour day. Needless to say gloom is in their hearts.

The experiences of these plants, whose names cannot for obvious reasons be given to the general public, but which are known to the editor, show the feasibility of adopting the eight hour day, yet there are many who fear to make the change. However they are sure to come to it sooner or later and it would be greatly to their advantage to take the initiative rather than wait to be forced.

A very recent experience of a firm that was forced to the eight-hour day is enlightening. The management noticed that the employees were getting ready to present demands for an eight-hour day and, in order to forestall trouble, granted them an increase in pay for which they had not asked. They grumblingly accepted the increase and one month later struck for and obtained an eight-hour day. The management has very materially increased its difficulties in meeting contract prices. When an aggressive man wants some particular thing, he may accept something else, but, nevertheless, he will eventually get what he wants.

However, as a plant can earn money only while operating, why should it stand idle seven-twelfths or two-thirds of the possible working time? Why not run 16 or 24 hours every day except Sundays and holidays? Of course such an arrangement means eight-hour shifts, but is a sure way of reducing expenses in most plants.

The actual effect on any plant is, of course, dependent upon the proportions of the labor, material, and burden costs, but figures recently prepared for a plant may be used for an illustration.

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The yearly burden figures for this plant when operating in different ways are as follows:—

EIGHT HOUR SHIFTS

	3 shifts	2 shifts	1 shift
Rent	$50,000	50,000	50,000
Power	45,000	28,000	12,000
Insurance ...	10,000	8,000	6,600
Depreciation .	30,000	24,000	18,000
Superintendence	29,800	23,200	16,600
Interest	30,000	30,000	30,000
Freight	20,000	14,000	7,000
Shipping	12,000	8,000	4,000
Repairs	15,000	10,000	5,000
Supplies	6,000	4,000	2,000
Shut down losses	2,600	15,000	15,000
	$250,400	214,200	166,200
Pounds produced ...	9,000,000	6,000,000	3,000,000
Burden per lb.	$0.0278	0.0357	0.0554
Burden per lb. in excess of 3 shift plan	....	0.0079	0.0276

In these figures the one and two shift plans have been greatly favored as the manufacturers did not want to deceive themselves into the three shift plan. The power account includes a very heavy figure for lighting on the three shift plan. Depreciation is charged off at a lower figure on the two and one shift plans than on the three, although it should be practically the same, for in a plant where all equipment is kept in repair, depreciation is an item to cover obsolescence. Freight and shipping are made proportional to the number of pounds manufactured, although they would be actually lower in proportion on the three shift plan, as that plan makes a carload shipment every day, while the two shift makes a carload every day and a half, and the one shift a carload every three days. Even with these allowances the manufacturing cost is overwhelmingly in favor of continuous operation.

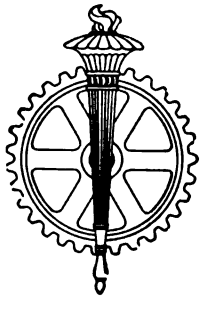
Other items of administration, sales, and general office expenses would still further favor the three shift plan, but have not been considered in order not to confuse the issue.

The selling price, in the case considered above, allows a net profit of three cents ($0.03) per pound over the cost on the three shift plan. This profit is reduced to $0.0221 on the two shift plan and to $0.0024 on the one shift plan. The total profit on the year's operation is therefore as follows:—

3 Shift	2 Shift	1 Shift
$270,000	$132,600	$7,200

The entire possible output of 9,000,000 pounds could be sold, but to manufacture it on a two shift plan cut the profit down to so low a figure as to make the enterprise unattractive, while to manufacture the amount on a one shift plan of either eight or ten hours would result in a loss.

In most industries competition is steadily becoming more severe, which means that costs must be reduced and labor kept satisfied. Modern methods of management combined with continuous operation of plants is the logical solution of the problem.



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MANAGEMENT OF CENTRAL STATIONS

By Walter N. Polakov

II. PRINCIPLES

In the first paper on this subject, presented in October, Mr. Polakov considered, as introduction to the organization of a power plant, the selection of location, the construction, the equipment, and the personnel. Herein he takes up the problems of practical operation,—efficiency and cost, planning of work, bonus, and training.—THE EDITORS.

THE year 1620, when Francis Bacon (Baron Verulam) published his epoch-making work entitled "Novum Organum," may justly be regarded as the date of the birth of modern or positive science. Rigorous observation and careful experiment, the accumulation of facts and systematic analysis of separate instances before probable truth could be affirmed—such is the general conception of Bacon's achievement. But, like all epoch-making works, "Novum Organum" gave expression to ideas which were already in the air. The time was ripe to wipe off the decaying scholasticism, and authority of churches, and traditions had been discarded. Any progress, especially in scientific discoveries, is made mainly, if not solely, by the employment of hypotheses, and for that Bacon's rules of induction cannot be applied. Yet the framing of an hypothesis is no mere guess work. It requires a preliminary critical induction and subsequent experimental comparison, verification, and proof, the canons for which may be laid down with precision. This task was surely accomplished by Bacon in his philosophy of induction, giving prominence to such powerful logical instruments as exclusion or elimination.

An engineer not equipped with a thorough knowledge of philosophic methods and not trained along the lines of logical scientific analysis is sure to fail to accomplish much in the profession. It can hardly be said that we know anything of the substance or nature of the forces with which an engineer must deal; electricity is not susceptible to any definition; heat may be explained by a half dozen different theories; hypothesis of phlogiston, atomistic theories, etc., are nothing more than an exhibition of our mental inability to understand the nature of things; and our efforts to represent the so-called "laws" of nature in mathematical form of equations and formulæ is nothing more than a method of memorizing certain similarities observed from phenomena. However, a frank admission of *ignorabimus* in respect to certain subjects does not diminish in the slightest the value of the present state of science; still less may it discourage the earnest effort to strive for further discoveries and a better understanding of phenomena with which we have to deal.

The application of the principles of scientific analysis, as should be expected, was first made to the research work conducted in laboratories, libraries, engineering bureaus, and it is only very recently through indefatig-

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able work by the late Dr. F. W. Taylor, H. L. Gantt, and a few others identified with the movement for scientific management that these scientific principles were applied to the every-day toil in our industries. Small wonder, therefore, that the central station is the most recent field opened for the application of scientific methods of management. Designers and builders of power equipment and plants making a thorough use of the present state of science apparently left nothing to do for the operating engineer and manager but to secure the maximum efficiency inherent in the machinery with which the plant is equipped. For scores of years this statement was accepted without question. Now the question looms large: *How are we to secure this ultimate efficiency inherent in the plant equipment?* This question involves another, prerequisite to the final aim, namely: *What is the maximum efficiency* of the given combination of units of equipment; and, finally, introducing the time element: *What is the possible maximum efficiency of the plant that results in the lowest cost of operation?*

The study of the factors involved in this problem, if it is to be fruitful of results, shall be conducted in compliance with the canons of scientific investigation. Unfortunately, it is seldom recognized that mere application to the practice of deductions drawn from researches and experiments conducted in one plant are not applicable at all, or in limited measure only, to some other condition existing in another plant. In this work the Baconian principle of eliminating non-essentials is the most serviceable one. If the "Table of Comparison" could be prepared and made exhaustively complete and our notions of respective phenomena made clear, the process of exclusion would be merely a mechanical counting out, and would *infallibly* lead to the detection of the cause or form. Such a condition can evidently never be fulfilled, and, therefore, the work of *scientific management is a creative task which in each individual case shall be carried out from the very beginning to its logical conclusion.* Any partial introduction of scientific method made to fit either pocket or fancy of the owner is for the very same reason a futile attempt.

Upon analyzing any practical problem a man with a mathematical turn of mind finds no difficulty in expressing its conditions in a form of an equation. Yet we know that many equations have several possible solutions; some equations with several unknown quantities have a very great number of possible solutions, each satisfying the equation. It is an absurdity, therefore, to claim that one result will be necessarily obtained from given causes. It is true, however, that the number of possible solutions is reduced by the improbability of some of them. For instance, $\sqrt{a^2}$ is not only equal to $+a$, but to $-a$ as well. In the equation $y^2 = 2px$, only one parabola is possible, another solution giving an irrational value for the y axis. Again, the same result could be obtained in different ways, as $+4$ may be the result of squaring ± 2, adding or multiplying, $2 + 2$, or 2×2, extracting square root of 16 ($\sqrt{16}$), in which latter case only one solution is satisfactory.

This selection of rational or desired result from the interplay of varied causes, and arrangement of causes to obtain the desired result, constitutes the art of the introduction of scientific management. Insufficiently clear understanding of this principle often creates a confusion of

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methods with principles, or a confusion of forms and implements with the method. *It is not the result that we seek, but the method.* Under proper method best result will be obtained unavoidably.

Quoting again from Francis Bacon:

"Whosoever knows any form, knows also the utmost possibility of superinducing that nature upon every variety of matter, and so is less restrained and tied in operation either to the basis of the matter or to the condition of the efficients." (Nov. Org. 1, 103.)

Thus the last step in the theoretical analysis gives the first means for the practical operation.

Efficiency and Cost

The first problem, both in logical sequence and in importance, that lies before the management is to ascertain with the utmost exactitude what is possible to accomplish with a given central station as regards thermal efficiency and cost of production.

This simple, and apparently inoffensive job, in reality is most difficult and complicated.

As the ultimate cost of product is always the governing criterion, in conducting a series of tests thermal efficiency sometimes shall be sacrificed to gain larger advantages in time-rate of generation of power, use of cheaper supplies, protecting equipment and customers from risk, interruptions, etc. Thus, in testing boilers, turbines, auxiliary apparatus, etc., what is wanted is not a maximum mark of highest thermal efficiency that could be obtained in each case, but an accurate knowledge, tantamount to certainty, *under what condition these best results can be duplicated at will.* When this knowledge is gained and recorded, a step further shall be made to integrate the sum of individual efficiencies so as to obtain the maximum efficiency when a variety of units are engaged in the process of transformation of power from one form into another. This task involves such questions as distribution of loads among several units, banking of extra boilers *versus* carrying light load on larger number of units, etc. Final selection is to be made, however, with due consideration of cost of product, convenience to attendants, safety of service, etc.

When all the available knowledge is gathered from this research work, showing what are the conditions under which the maximum *financial efficiency* can be obtained, the problem resolves itself into determination of standard of performance. That is, we must carefully define the limit of operating economy below which we shall not go and which can be obtained with scientific certainty by maintaining the conditions disclosed in preceding studies. From this definition we derive two conclusions:

1. Deviations either way from the *standard result* are not desirable—the cost of product being higher if the standard is not attained, due to low thermal efficiency; or the cost of product may be increased by a high thermal efficiency of some single process which may either lower the final efficiency or increase the expense of attaining it.

2. Conditions creating the standard result are known and under control.

Now, in assigning the task for the power plant attendants, it is necessary and sufficient to prescribe only the *condition* which shall be maintained by them; the desired *result,* if study is made correctly, will be obtained necessarily.

Inasmuch as not the *result,* but *maintenance of condition* constitutes the task, these two far-reaching characteristics of this form of management may be noted.

1. Management assumes the responsibility for the result.

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2. Management in offering bonus for accomplishment of task shall not vary the bonus rate.

Such are the principle characteristics of our task with bonus method as applied to power plants. Proper carrying out of this method requires certain prerequisites and produces results which we now can briefly outline.

Planning of Work

It is almost self-evident that requiring the men to maintain the prescribed conditions governing the process of transformation of power, like certain ways of feeding coal into a furnace, force of draft, manner of pumping water, blowing off boilers, etc., and to maintain a definite degree of superheat, vacuum, temperature of feed, loading up generators in accordance with given schedule, etc., is not possible unless certain conditions are maintained by the management, such as: 1, standardizing supplies, *i.e.*, issuing them regularly in quality and quantity best adapted to use; 2, maintaining uniform equipment in the best working condition; 3, defining methods clearly, standardizing them, and making them known to the men through instruction cards and personal training.

In order to handle supplies used in power plant work, a special organization of the store room is necessary. The double bin system is the best, wherein two bins are provided for each article, and their size so regulated that both bins when full hold the quantity of store most advantageously without risking deterioration. Issues upon receipt of issue cards are made from one bin until it is empty—this signifies that an order for new purchase shall be made, so that the new supply will arrive before the quantity on hand is exhausted. Each bin is provided with a tag upon which entries are made of each issue and the balance on hand is marked, which, together with "Balance of Stores" card in the office files constitutes a permanent inventory.

In order to maintain the equipment in best condition at all times the repair or maintenance work shall be carefully standardized, scheduling all regular inspections, overhaulings, etc., and planning as far as possible to foresee all repair work, remembering that "a stitch in time saves nine." To handle this work a "tickler" system is used, consisting in depositing memoranda in folders ahead of time for any day of the year when next inspection, etc., shall take place, and drawing from the daily folder each morning all notes for execution on that day.

If the work is complicated in its nature or of some magnitude, in order to eliminate loss of time due to an undecided method of procedure, choice of tool, selection of material needed, selection of proper man, etc., special "Work Orders" are used, showing what work is to be done and when, accompanied, if necessary, with a complete instruction card, drawings, etc. At the time the man is assigned to such a job he is simultaneously provided with a basket containing all necessary tools, and all required material is delivered to the place of his work.

The time spent by either operating or maintenance men on certain work is both recorded and planned ahead of time on a "planning board." Each man has on this board three time tickets; the upper one is dated, time, job, etc., entered upon it, and it indicates what the man is engaged in *now*. The second ticket is prepared for a job which will be given to the man *next*, when he is through with the present work, at which time the ticket is moved to the upper hook and timed, while the finished job ticket

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goes on record. A third hook keeps all such tickets that are prepared for jobs planned for a man for the *future*. By this means there is no guess work as to what is being done now and what is to be done next. Everything is in readiness for any man reporting for work. For recording the cost of work, all time tickets and store issues are kept in a folder for each job on the reverse side of the planning board until the work is completed, when all time and material charges are added and properly entered on due accounts. The method in which the work shall be performed is standardized after careful study, and written in plain concise language. All such instructions dealing with general matters of routine are called "Standing Orders." All constituting rules and regulations descriptive of methods or practice to be followed in individual cases are called "Instruction Cards," and are issued to the man for guidance in performing a definite task.

Bonus

Inasmuch as under this plan the management assumes the responsibility in properly setting the task, in proper instructions for accomplishing the task, in maintaining equipment, supplies, and tools in a condition permitting the accomplishment of the task, and in assigning men to work at proper times, it naturally assumes the responsibility for result obtained if men are living up to instructions. Therefore in order to stimulate a man to learn how to do the work in the best manner prescribed in the instruction card, and to compensate him in addition to his guaranteed daily wage for his increased value to the company, the bonus is paid over and above his guaranteed wage. The amount of bonus paid will naturally vary within certain limits, the maximum being when the bonus is equal to the saving due to the improved condition, and the minimum when bonus is not attractive to the men. Within these two limits the actual figure shall be determined, differing for each class of work, so that a task requiring more mental strain or attention, or more difficult physically to accomplish, shall be compensated with higher bonus than a task requiring merely obedience to instructions or force of habit. Again, work done in unpleasant surroundings shall bring larger bonus than that done with perfect comfort. This bonus is not increased or decreased for the same task, no matter whether the results are just standard or in excess. The general reason for it is already explained; but in case of manual labor, like handling coal or ashes, the sliding or increased bonus for more work than specified shall be equally discouraged, as injudicious striving for higher earnings may have an ill effect on the workman's health. In such cases a limit for physical work is determined in setting a task, and should the man accomplish the full amount of work in less time than allowed, he is compelled to take rest rather than overtax himself and ultimately put the system into disrepute.

The foregoing plainly shows the difference between the bonus and "premium plan." *Premium is paid for results* when the management is either too weak or too ignorant to tell the men how to perform a job. Opposed to this, the management, knowing that with their guidance and help the desired result will necessarily follow, does not need to resort to premium offered for the accomplishment of results, but can reach the desired ends by teaching the men what the management already *knows*, and then giving a bonus to those who learn.

Both bonus and premiums are extra

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compensations for special merits of individuals or gangs, whereas so-called "profit sharing" is a mere gift proposition wherein the men may or may not get extra compensation depending upon whether business has been profitable or not.

It is an indisputable fact that the bonus is a strong incentive for men to learn the best way of performing their work, as well as a just compensation for the increased value of their services, and in both these respects it offers a special problem in recording.

The fact whether bonus was earned or not shall be ascertained before the man returns to work next day, as this gives him a stimulus to work efficiently, or to find out what caused the loss of bonus so that he may avoid this mistake in future. For this reason, every time a man fails to live up to his task an immediate investigation is instigated, and instead of a bonus slip the man is given next day a "lost bonus slip" stating briefly why he failed.

Inasmuch as bonus necessarily reflects the efficiency of the work, a mere glance at the bonus record sheet tells to the superintendent, or other official, the story in a plain language of red and black marks against each man for each day, indicating who missed his bonus and when; that is, dropped the efficiency below the standard.

Training

From the above it is plain that the whole plan is based on an educational campaign with a reward to those who learn. The training of men is, therefore, one of the very important functions of management, and the most difficult part of this work is to combat the force of old habits. Such work requires time, persistence, and knowledge of human nature, and to carry the scheme of increasing efficiency into an existing plant requires the services of specially trained experts in each line of power-plant work. Working as instructors, helping and training men to accomplish their tasks, qualifies them later to become inspectors, or investigators, or bosses, and in this capacity to continue to help, train, and encourage the men. It is logical, therefore, that they shall receive their share of bonus, and as their work consists in training the bonus workers their bonus is based, not on the degree of efficiency attained by each of the men, but on the number of their pupils who earn their bonus under their guidance. The amount of a foreman's bonus is usually doubled when all men in the gang earn their bonus, so that instructors are stimulated to help most the ones who are backward.

In the final count it is not the inherent efficiency of plant equipment, nor the cost of supplies, nor the bulk of business that determines the degree of efficiency of the plant or the profit and loss of the enterprise, but it is the *men* who operate the equipment more or less properly, the men who waste or use fuel and supplies efficiently, the men who co-ordinate knowledge and efforts in all stages of the process of power generation, that ultimately achieve or miss the goal. For this reason we maintain, that of all functions of central station management the all important one is the study of men—to find out definitely and exactly what each man is best fitted for, and to train him and encourage him to the limit of his ambition. Yet it is possible to accomplish this only under one condition—that the means and the end is beneficial to mankind. When this criterion is lost or substituted by a narrow, selfish, temporary ideal, the highest degree of efficiency is but a curse.

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THE LATEST STEPS IN RADIO TELEPHONY

By Harold Pender

The whole country was amazed a few weeks ago by the announcement that long distance telephony without the use of wires had actually been achieved and was demonstrated from Arlington, first to San Francisco, then to Honolulu, and finally to the Eiffel tower at Paris. Dr. Pender, professor of Electrical Engineering at the University of Pennsylvania, tells how this great development was accomplished.—THE EDITORS.

IN an article published in October, 1914, by one of the leading wireless experts in this country, is the statement: "Wireless telepnony, though not in general use, is easily practicable up to a distance of 100 miles." Thus curtly was the status of radio telephony dismissed a little over twelve months ago. No wonder, then, that scientists, to say nothing of the public at large, were startled almost to the point of unbelief to read in the daily papers on September 30th, 1915, that the speech of a man in Arlington (near Washington) was heard instantly and with all the modulations of the speaker's voice, in Honolulu, a distance of 4,900 miles, without the use of wires. Though startling, this information was entirely correct. The performance at each end was witnessed not only by the engineers of the Company which has made this feat possible, but also by officers of the United States Navy.

The exact date of this achievement is September 29th, 1915. Earlier on the same day speech had been transmitted without wires from Arlington to San Francisco, 2,500 miles, from Arlington to San Diego, 2,300 miles, and from Arlington to Darien on the Isthmus of Panama, 2,100 miles. These were the places at which had been installed apparatus to pick up the ether waves and convert them into sound. That the words were not also heard at the North Pole, Petrograd, Rome, and Rio Janeiro, and all intermediate points, was due solely to the lack of receiving apparatus at these places. The waves arrived and the speech could have been heard had the apparatus for their conversion into sound been available.

Less than two weeks later words spoken at Arlington were actually picked up by a special receiving equipment on the Eiffel Tower in Paris, and by October 20th, the results obtained at this station were satisfactory beyond all question.

In addition to transmitting speech without wires over these great distances, the ability to transmit speech part of the way by wire and the rest of the way by radio was also demonstrated. On the same day that speech was transmitted by radio from Washington to Honolulu, the voice of Theo. N. Vail, President of the American Telephone and Telegraph Company, entering an ordinary transmitter in New York City, was faithfully reproduced in San Francisco, traveling by wire to Arlington and thence by radio to San Francisco.

These magnificent achievements, the most spectacular, the most fascinating in all the annals of science, were accomplished not by one man, nor in one day. They are the crowning results of many years of research by a large corps of engineers all work-

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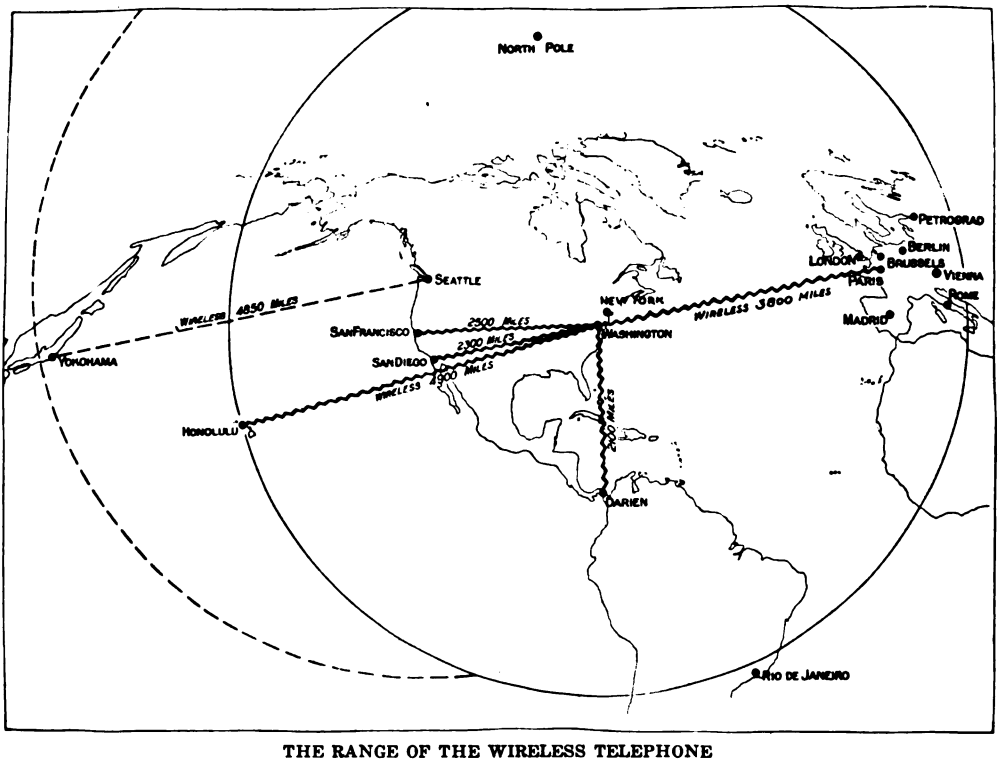
ing together for the same end, having in the final stages the active coöperation of the French Government and the Navy Department of the United States. To name the engineers would be to name practically the entire research staff of the American Telephone and Telegraph Company and the Western Electric Company.

cial use on January 25, 1915, is largely due the success obtained in the radio transmission of speech.

The first application of these ideas to radio telephony over any great distance was made early in the present year between an experimental sending station at Montauk Point, Long Island, and a small, privately owned,



THE RANGE OF THE WIRELESS TELEPHONE

The solid circle shows the territory within a radius from Washington of 4,900 miles, the distance from Washington to Honolulu, which was reached by a wireless telephone message, September 29, 1915. The same message could have been heard at a properly equipped radio tower at any point within the circle. The dotted circle of equal radius shows that a telephone message from a wireless station at Seattle could be heard at Yokohama. Paris was reached October 21, and the message was also heard at Honolulu.

The details of the final "acceptance" tests, if one may use this term in referring to the above results, have been published in various papers and technical journals. To the engineer, however, the story of the preliminary work leading up to these tests is of more absorbing interest. To the ideas suggested and developed in the working out of the transcontinental line of the American Telephone and Telegraph Company, opened for commercial use on January 25, 1915, is largely due the success obtained in the radio transmission of speech.

The first application of these ideas to radio telephony over any great distance was made early in the present year between an experimental sending station at Montauk Point, Long Island, and a small, privately owned, receiving station in Wilmington, Delaware. The results obtained were so satisfactory that a crude receiving station was then erected at St. Simons Island on the southern coast of Georgia, a distance of about 1,000 miles. The sending equipment at Montauk was soon perfected to such an extent that talking from an ordinary desk set at Montauk Point by radio to St. Simons Island became a regular daily performance. In these

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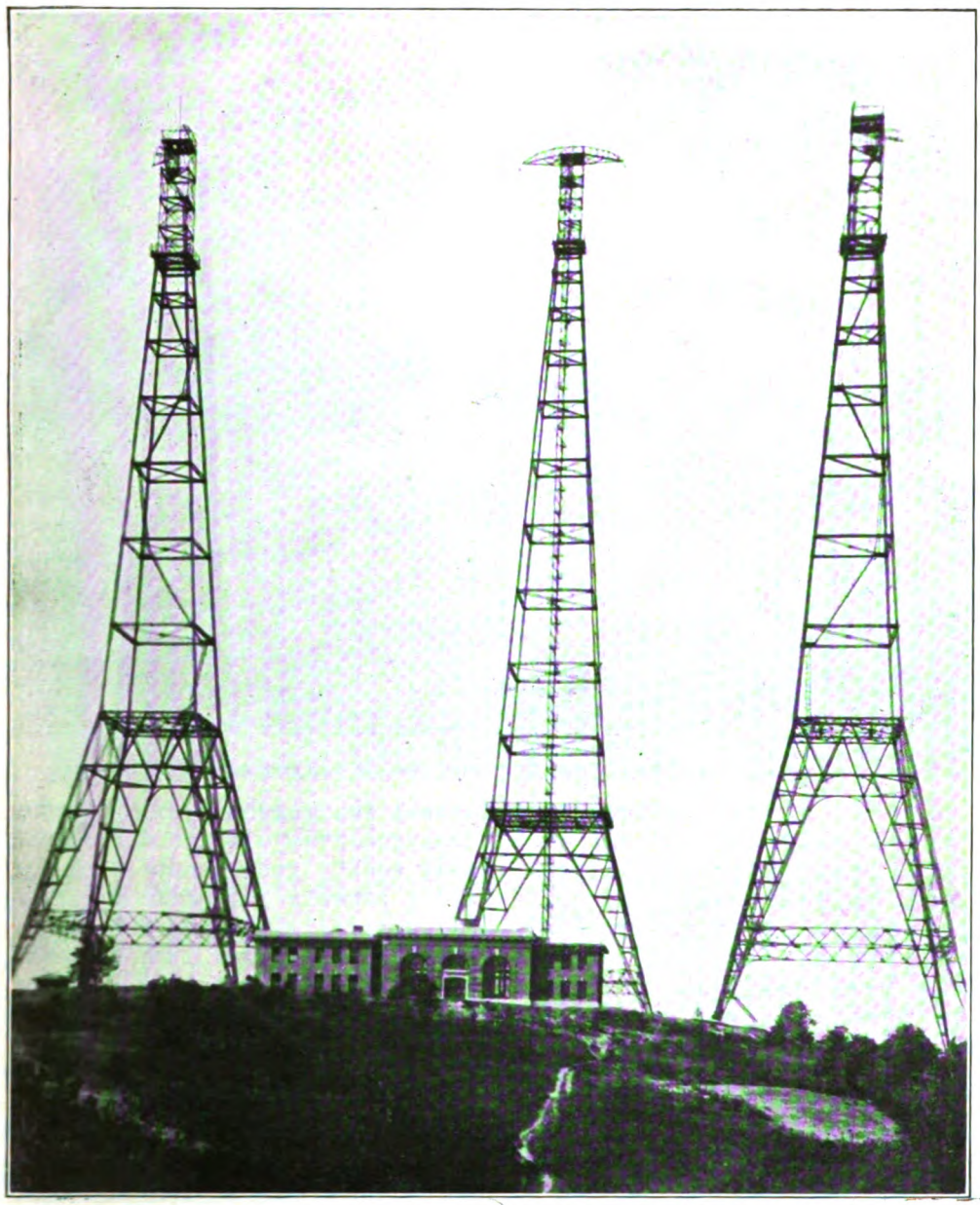

RADIO TOWERS AT ARLINGTON, VIRGINIA. FROM THESE TOWERS THE IMPULSES OF THE HUMAN VOICE WERE SENT TO PARIS AND TO HONOLULU

tests the speech in the reverse direction was carried over a regular telephone circuit, as there was no sending equipment at St. Simons Island.

These preliminary trials fully demonstrated the feasibility of the method used for long distance radio telephony. To try still greater distances it was only a matter of obtaining a more powerful sending equipment and a larger antenna. Through the courtesy of the Navy Department the powerful antenna at Arlington, near Washington, was placed at the dis-

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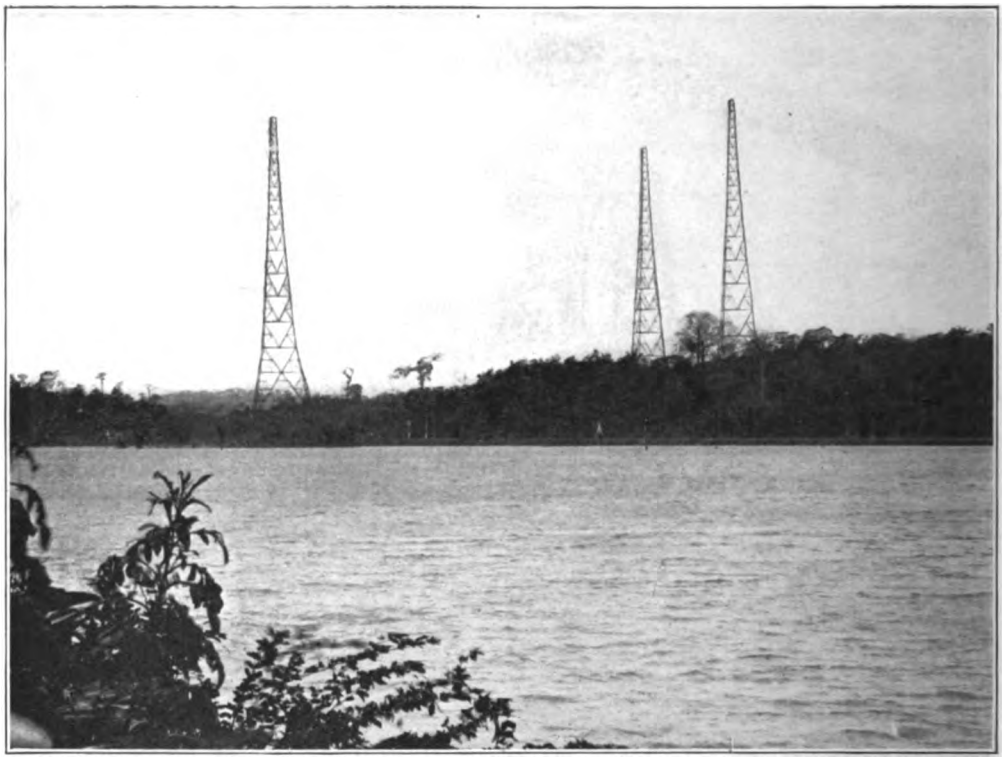

DARIEN RADIO STATION ON THE BANK OF THE PANAMA CANAL

posal of the Telephone Company for a limited period each day, as were also the Naval Radio Stations at Mare Island, San Diego, Darien, and Honolulu. This was in the spring of this year. At the same time arrangements were made with the French Government whereby representatives of the American Telephone and Telegraph Company could have the use of the antenna on the Eiffel Tower for a few minutes each day. Only when one remembers that the Eiffel Tower is in continuous use by the French Government in transmitting military information, can the extent of this courtesy be appreciated.

Throughout the summer the development and improvement of the apparatus went on, and in August conversation by radio from Arlington to Darien was established. After a few preliminary trials, daily transmission became the regular thing, despite heavy static disturbances at Panama. Later equally good results were obtained between Arlington and San Francisco, Arlington and San Diego, and, since September 29th, between Arlington and Honolulu, a distance of 4,900 miles.

The results at Honolulu are all the more remarkable in that the antenna there used was a makeshift affair, consisting of four or five wires strung between a smokestack 100 feet high and a water tank 80 feet high, the span being 250 feet in length. The metal surface upon which the ether waves from Arlington impinged was less than 50 square feet in area. Comparing this with the area of a hemisphere having a radius of 4,900 miles (4,200,000,000,000,000 square feet), one may obtain some idea of what part of the energy radiated at Arling-

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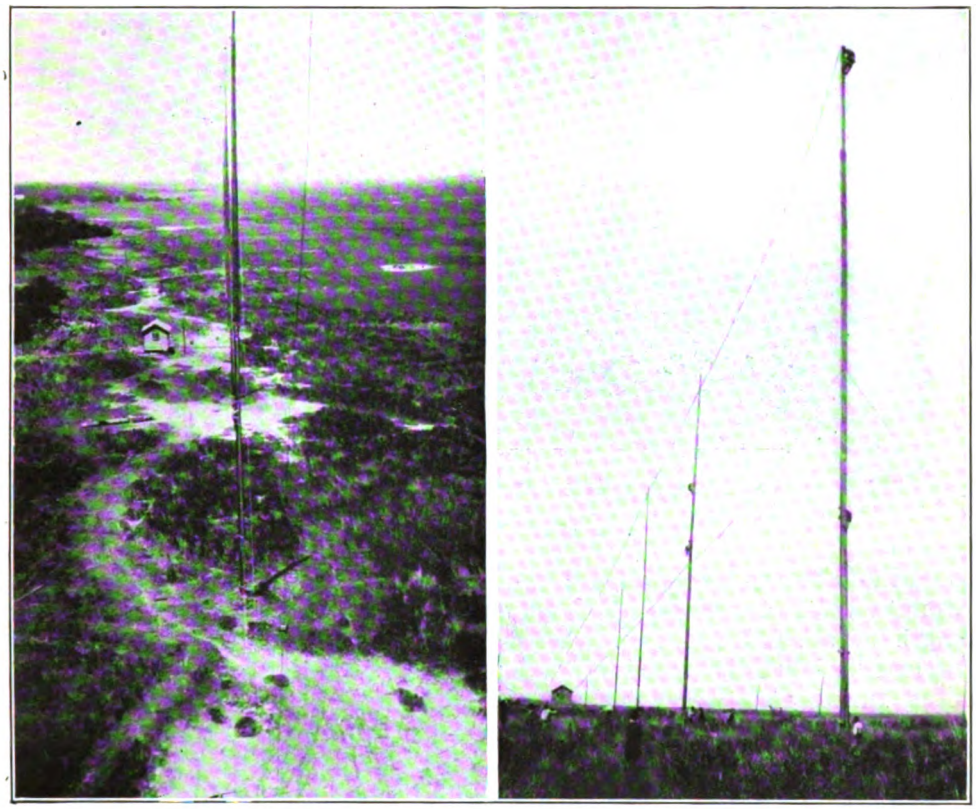

EXPERIMENTAL TOWERS AT ST. SIMONS ISLAND, GEORGIA
These towers are 120 feet high, built of spliced wooden poles.

ton was actually utilized in exciting the receiver at Honolulu. As one of the engineers engaged on this work remarked, possibly a millionth of a mouse-power would be a fair estimate of the power required to excite the receiving apparatus. Yet, so distinct were the words as heard through an ordinary telephone receiver connected to this apparatus, that the operator in Honolulu actually recognized the voice of the man speaking in Arlington, and with the ear three feet from the receiver!

As noted above, satisfactory results were not obtained in Paris until October 12th. This, however, was due not to defects in the apparatus, but to the abnormal conditions under which the tests necessarily had to be made. Never did the engineers sent by the Telephone Company to Paris have the use of the antenna for more than a total of 20 minutes a day, and then only for alternate five minute intervals. Moreover, communication from Paris to Arlington was possible only by cable, and subject to delays due to censorship. Again, owing to the large number of relatively nearby high power radio telegraph stations in Europe, it was difficult to select a wave length which was reasonably free from interference. Only at very long wave lengths, for which the sending antenna and the apparatus installed at Arlington were found to be somewhat inefficient, or at wave lengths much shorter than those normally employed in long distance radio working

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RADIO STATION AT SAN DIEGO, CALIFORNIA
The two poles on the left are 150 feet high and belongs to the small sending set. The pole on the right belongs to the 300 foot antenna.

could interference be eliminated. The result was a compromise, a wave length of about 5,000 meters being employed. With the receiving apparatus tuned for this wave length, which was shorter than the wave lengths normally employed for trans-Atlantic working and which was not outside the range of station interference at Paris, words spoken in Arlington were heard in the receiver in Paris, not only by the Telephone Company's engineers, but also by several officers of the French Radio Telegraph Service.

Now that radio telephony over long distances has been shown to be both feasible and practicable, the question naturally arises as to what will be the field of application of this new method of transmitting intelligence. Before expressing an opinion on this point, let us first consider the inherent limitations of radio communication in general, and of wireless telephony in particular.

All radio transmission is by means of electromagnetic waves in the ether, which may be defined as the universal medium surrounding and permeating all matter. A copper wire may be insulated from surrounding matter, so that electrical impulses sent along it will not spread into the surrounding space, but there is no known means of insulating any portion of the ether from any other portion. The result is that an electrical disturbance produced at any point in the ether spreads out in all directions, just as the sound of a pistol shot (or to be exact, the disturbance in the air produced by such a shot) spreads out in all directions. Hence, when one speaks by radio from Washington to Honolulu, every word that is uttered can be heard at every point within the same distance of Washington, namely, all over the United States, Canada, Central America, the northern part of South America, the eastern part of Africa, and over practically all of Europe. Of course a receiving device is required in order to hear the words at any place, just as an ear is required to hear the sound of the pistol shot.

Imagine, then, the result of an attempt to carry on simultaneously even half a dozen conversations between the eastern seaboard of this country and Europe. Fortunately, the case is

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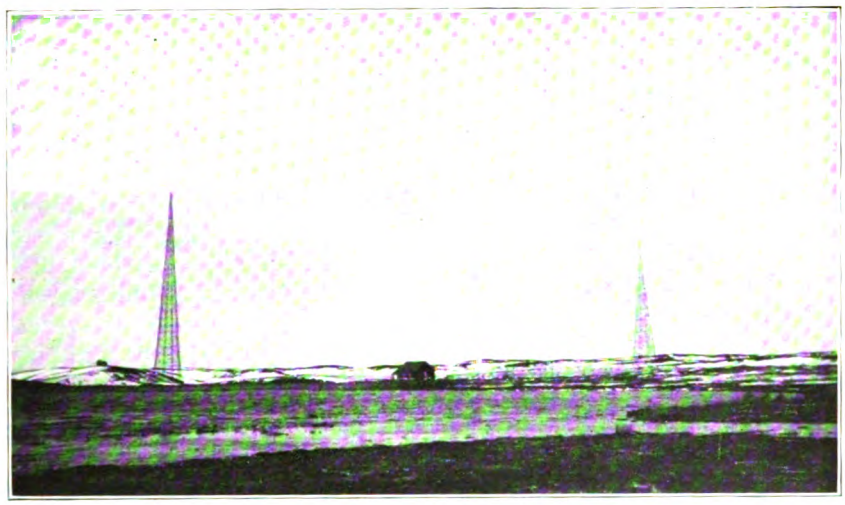

VIEW OF THE AMERICAN TELEPHONE AND TELEGRAPH EXPERIMENTAL RADIO STATION AT MONTAUK POINT, L. I.

not quite as bad as it would appear at first sight. Although the ether waves cannot be confined, the receiving apparatus (the "electrical ear") can be *tuned* so that it will respond only to certain predetermined wave lengths. This principle is well known and is commonly employed in radio telegraph working. The range of wave length which can be used practically in long distance working is from about 3,000 to 15,000 meters, corresponding to electromagnetic wave (or radio) frequencies of from 100,000 to 20,000 periods per second. The number of "tuned" conversations will then depend only upon the sharpness with which the receiving apparatus may be tuned.

It is just here that radio telephony is at a decided disadvantage as compared with radio telegraphy. In the latter all signals are made up of but two elements, a dot and a dash, and the only difference between these two is in their relative duration. Therefore all radio telegraph signals from one station to another may be transmitted at a single frequency, and the only limit to the number of simultaneous transmissions is the closeness with which the tuning of the different sending and receiving sets may be effected.

A spoken word, however, is itself made up of a combination of audible frequencies, ranging from about 40 periods per second to over 2,000 periods per second. Each of these frequencies must be faithfully reproduced in the electromagnetic wave, which means that the sending apparatus must be capable of sending out not only waves having a mean frequency of a given value, for example, 50,000 periods per second, but must also be capable of sending out with the same relative intensity waves having a frequency as low as 48,000 and as high as 52,000 periods per second, and the receiving apparatus must be equally sensitive to all frequencies within this range. In short, each radio telephone conversation requires a "band" of frequencies in the radio spectrum, and this band must have a width of at least 4,000 on the frequency scale. Comparing this with the available range of frequencies, 20,000 to 100,000, it is evident that certainly not more than 20 long distance conversations could be carried

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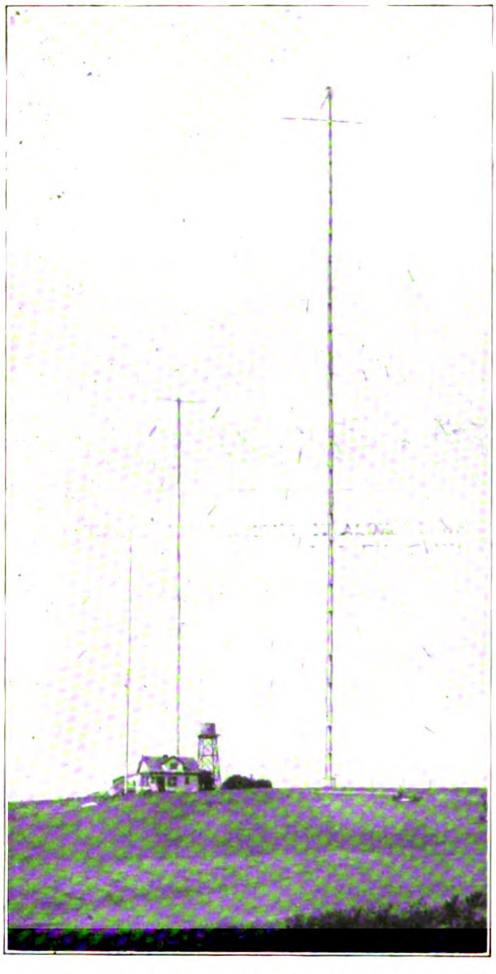

NAVAL RADIO STATION AT MARE ISLAND, CALIFORNIA

on simultaneously, either from one station or from any number of stations, unless the latter were separated by distances comparable with the distance between the calling and answering stations. By distributing receiving and sending stations along the Atlantic Coast from Canada to Mexico, and placing the control of both the pitch and intensity of each station under one central authority, probably a total of 50 simltaneous conversations could be maintained with ships in the Atlantic and with European cities, the majority of these conversations being from shore to ship.

Even with the pitch and intensity under the control of a central authority, radio telephone conversations will still be under the disadvantage, as compared with wire telephony, that any outsider with the necessary receiving apparatus can "listen in." A radio telegraph message can also be picked up by an outsider, but whereas radio telegraph messages can be transmitted in code, conversation cannot well be coded without thereby losing practically all its superiority over a telegraph message.

So far, no consideration has been given to the so-called static disturbances, which are the bane of radio telegraph working, and which are equally disastrous to radio telephony. Listening through a telephone receiver at a radio telegraph station when there is an electric storm within the range of the station has been compared to trying to hear a watch tick in a boiler factory. One advantage of the radio telephone over the radio telegraph is that if but a portion of the word is heard the ear can often supply the rest, whereas if a dot or dash in a radio telegraph message is obliterated, the whole word is lost. However, the general experience of all engineers conversant with radio operations has shown that static disturbances in the ether are frequently continuous for hours and even days at a time during certain seasons of the year and are sometimes so severe as to make all radio communication impossible.

A careful consideration of the work already accomplished and the inherent limitations of radio working warrants the following conclusions:

1. Perfectly satisfactory radio telephony is possible, under favorable conditions, over distances up to 5,000 miles, and probably more.

2. Any existing telephone line may be connected directly to a properly

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designed radio station, at either the sending or receiving end, or at both ends, and speech may be transmitted over this composite circuit. For example, when suitable sending and receiving stations on both sides of the Atlantic have been erected, it will be possible for any telephone subscriber in the United States to talk directly with any telephone subscriber in Europe.

3. The possibilities enumerated in the preceding paragraph also apply to telegraphic communication, for the apparatus developed in connection with radio telephonic transmission may be used, with even greater ease, for the radio link in any telegraphic system.

4. If small radio telephone sets which will not require expert attendance can be developed, and there seems to be every probability that such will be the case, the use of radio for ship to ship and ship to shore communication will be greatly extended. The elimination of the radio operator will make possible the use of radio communication by thousands of ships which cannot afford the expense incidental to the operation of the present radio telegraph system, the chief item of which is the operator's salary.

5. For transoceanic *telephonic* communication the radio system is the only system available, due to the inherent difficulties of telephonic communication over a long submarine cable. With respect to both continuity and privacy such service will probably always be at a disadvantage as compared with the cable service.

6. Where a wire circuit can be installed and maintained it will usually prove more economical, and in every case more reliable, to use such a circuit in preference to any radio system.

Based upon our present knowledge it seems safe to predict that radio telephony will in no sense become a substitute for wire telephony, but will serve as an important adjunct thereto, making possible the extension of telephonic communication into regions where wire telephony is impracticable. Its most extensive field of application will probably be that of communication between ship and ship and between ship and shore. In addition there will also be a limited transoceanic service. More than this can hardly be expected, and even this much can be accomplished satisfactorily only when the use of the ether for radio communication is placed under the control of some central authority with power to restrict its use only to those services which cannot be given by other means. The limitation of a single conducting medium for all kinds of radio communication seems to preclude any serious competition between the radio and the land lines and submarine cables.

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RECORDING POWER PLANT OPERATIONS

By Julian C. Smallwood

IV. THE RECORDS: COMBINING, AVERAGING, INTEGRATING, AND FILING; SPECIAL PLANIMETERS.

This, the fourth and last of Professor Smallwood's intimate series on the metering of generated power, rounds out the subject by a discussion of the handling of records after they are obtained, particularly their correlation and integration. So comprehensive a treatment of a neglected field as Professor Smallwood has given in his four papers cannot fail to effect a measurable advance in the application of power-plant economies.—THE EDITORS.

NO matter how accurately and completely autographic records are made, their value is small if they are not carefully studied with relation to one another. A mere accumulation of data is about as useful as gold kept in a teapot. Both have potentialities which may be released by manipulation but not by hoarding.

It behooves the uptodate power-plant manager, then, not only to be thoroughly provided with measuring instruments but to devise and use a system of accounting the combined results of continuous measurements so that their significance may be readily grasped in toto and acted upon. Such combined results are, if well undertaken, equivalent to a test for the period considered. Thus by the use of modern autographic apparatus, power plants may be continously under test, a condition which is, in view of the variable character of power-making processes, highly desirable in every way—in fact, essential to economic survival.

Aside from obtaining the exact cost of power, accounting systems are kept with the following purposes so far as concerns autographic data.

1. To establish standards of efficiency of units and of plant, entailing the determination of the best operating conditions and accessories. This includes such items as grade of fuel, method of firing, type of grates, interval between boiler-cleanings, valve setting of engines, and so on.

2. Having established these conditions and found exact values of the performance of units and plant corresponding to maximum efficiency, to maintain daily efficiencies approximating as nearly as possible to the standard.

The standard of efficiency as found for the first purpose will always be higher than may be secured under ordinary daily operation. In the latter case a unit may be called upon to meet a highly variable demand and furthermore its physical condition deteriorates between overhaulings; but an accurate test for purposes of comparison requires that all the measured quantities be uniform throughout the test and all operating conditions as nearly ideal as possible. Suppose, for example, that we wished to compare the relative economy and adaptability of two grades of coal. We might use each for a month and then compare the costs of power for the two periods, but the comparison would not by any means be exact on account of the probability of wide variations in the performance of both units and operatives, from causes not relating to the fuel. Instead, the proper procedure would be to operate a given boiler at a definite load under definite conditions, first with one coal and then the other. For thoroughness we should repeat these

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tests at various boiler outputs, making perhaps six or eight tests in all. We could then make a reasonably correct decision. Naturally for such trials special attention and more complete records should be used.

BOILER PERFORMANCE DATE_____			
Boiler No.	1	2	3
Hours in service			
Total water			
Total coal			
Total ash			
Steam pressure			
Superheat			
Feed temp.			
Factor, evaport'n.			
Equivalent evap.			

FIG. 1. LOG FOR BOILER RECORDS

BOILER PERFORMANCE DATE_____			
Boiler No.	1	2	3
Hours in service			
% CO_2			
Flue gas temp.			
Draft			
Boiler effic.			

FIG. 2. LOG FOR BOILER RECORDS

ENGINE PERFORMANCE DATE_____				
Engine No.	1	2	3	Etc.
Hours in service				
Total steam				
Kilowatt-hrs.				
Lbs. steam per kw-hr.				
Steam pressure				
Back pressure				
Quality steam				
R.p.m.				

FIG. 3. LOG FOR ENGINE RECORDS

TOTAL QUANTITIES DATE_____			
	Steam	Kw.-hrs.	Coal
Engine No. 1			No. 1
Engine No. 2			No. 2
Etc.			Etc.
Blow-off			
Auxiliaries, and leaks			
Totals			
Lbs. of coal per kw.-hr.			

FIG. 4. LOG FOR RESULTS OF PLANT

Recent advances in autographic apparatus have made it possible now to test fully boilers and engines without any necessity whatever of hand recording of quantities, the business of the experimenter being merely to maintain uniformity of conditions during the test period. Thus a boiler test may be made with a coal meter and electrical time recorder attached, a water- or steam-flow meter, a pressure gage, a feed-water thermometer, and preferably a CO_2 recorder to secure the carrying of the best fire possible. If the steam is superheated, its quality is readily obtainable with an additional thermometer; if not, the error resulting from the assumption that it is saturated is generally negligible for comparative tests on the same boiler. With wet steam, if an actual determination of quality is desired, it is a simple matter to combine a recording thermometer with a throttling calorimeter so that, with the pressure records, substantially correct values of the percentage of dryness may be figured.

Similar considerations should prevail when determining best engine performance. The unit under test being kept at constant output, the necessary instruments are: A steam flow or condensate meter, a pressure gage on the steam and one on the exhaust line, and a wattmeter or a continuous indicator. Steam qualities may be obtained as for a boiler test. With such apparatus engine trials become charmingly easy in that, since rates only are recorded and there is no error from starting and stopping, a short test will suffice. All that is necessary is that the engine be run long enough to "find itself" and settle down with respect to the load. This is a marked

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improvement upon the old and laborious method of measuring total feed water or condensate over a period of four or five hours.

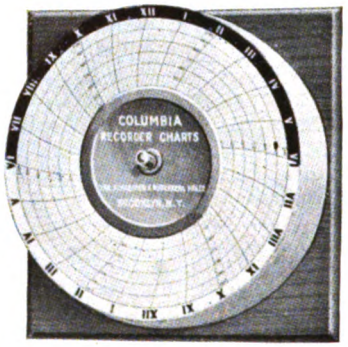

FIG. 5. SCHAEFFER & BUDENBERG'S COLUMBIA CHART HOLDER

Having secured complete autographic boiler or engine records, it is necessary to figure from them results in terms of equivalent evaporation or steam consumption, and for this purpose some of the records must be integrated and some averaged. Methods of doing the latter will be taken up later in this article.

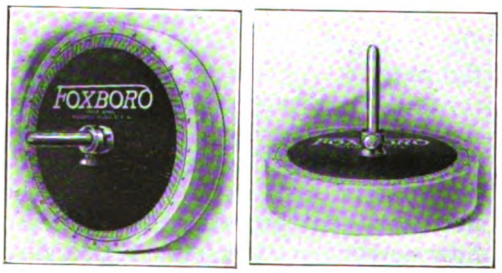

FIG. 6. FILE FOR CHART RECORDS

After establishing by these means the best operating conditions and ascertaining the best performance of units in the matter of heat consumption, we may then apply our recording apparatus to the second object mentioned, the daily maintenance of efficiency. This involves the combining of daily totals and averages shown by the records, and transferring the results to some simple form of log by which they may be compared and studied. The system of accounting must be appropriate to the particular plant under consideration, and may if we like include the other items generally listed in power-cost accounting, such as repairs, waste, lubricants, etc. Appropriate systems and log forms are almost as numerous as the plants themselves, differing with the exigencies imposed by different arrangements of plant units and metering equipment. Consequently only suggestions and not specific detailed information may be given.

COMBINING, ACCOUNTING AND FILING

According to the writer's notion, the most satisfactory arrangement is to have separate accounts for each main unit in order that its performance may be separately analyzed, and a grand total account for the plant obtained from the unit accounts. These may be kept in three ways: In bound or loose-leaf book, on cards, or by plotting the results on a single chart. The items may be readily transferred from the autographic records in the loose-leaf or card systems, but in the chart system there is opportunity to make mistakes in locating points. The last system, however, has the great advantage of furnishing a ready comparison of daily results, with one another and with the standard.

Figure 1 is a form for entering boiler items from a complete metering equipment measuring input and output. All of the data are directly obtainable from the autographic records except, of course, the calculated results and the figures for ash. The calculated results are reckoned from the other items, the equivalent evaporation being based on combustible. As routine procedure the ash and refuse may be figured from the known percentage in the coal (from

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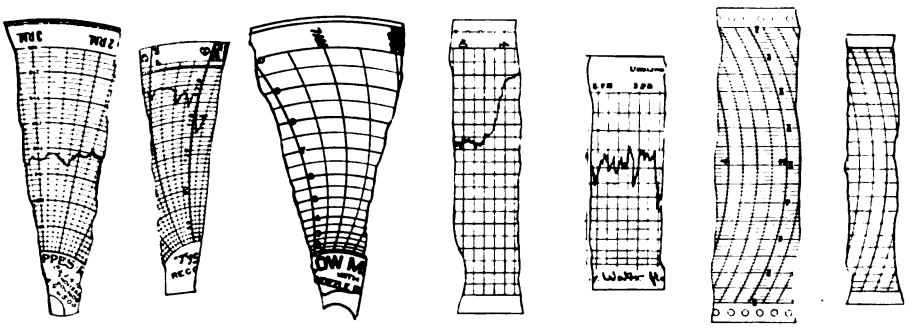

I II III IV V VI VII

FIG. 7. EXAMPLES OF CHARTS WITH VARIOUS TYPES OF CO-ORDINATES

proximate analyses) and an allowance made for grate losses, but this estimate should occasionally be checked by actual weighing. When feed-water temperatures and steam quality are not measured, these items are omitted from the log and an estimate is made of the factor of evaporation. The average percentage of boiler rating may be entered if desired but it is not essential, since a brief consideration of the first two items gives one an adequate idea of this. Cards of this form may be filled out daily and filed in time sequence, or one may be completed for each shift. Standard performance results corresponding to maximum efficiency should be entered for purposes of comparison, on a log like that for daily use.

Figure 2 represents a log to be used when wastes are measured instead of output and input. All of the data are directly obtainable from the autographic records except the last, which may be readily and closely estimated from the averages of CO_2 percentage and flue gas temperatures as previously described.

If the chart method of accounting is followed, significant averages of autographic records and calculated results are to be plotted on a 30-day chart, quantities pertaining to a whole day or to each shift being used. Such items as CO_2, flue-gas temperatures, boiler efficiency, equivalent evaporation, shown in this way are highly indicative; and when placed conspicuously in the boiler room furnish a fine incentive to competition on the part of operatives, since not only may present individual results be compared with past, but the results of each individual may be compared with those of the others. Standard results may be shown by heavy, straight, horizontal lines, and the deviations of the daily curves from these standard lines indicate clearly a falling off of efficiency. One chart may be used for a number of boilers by drawing each curve with a differently colored ink.

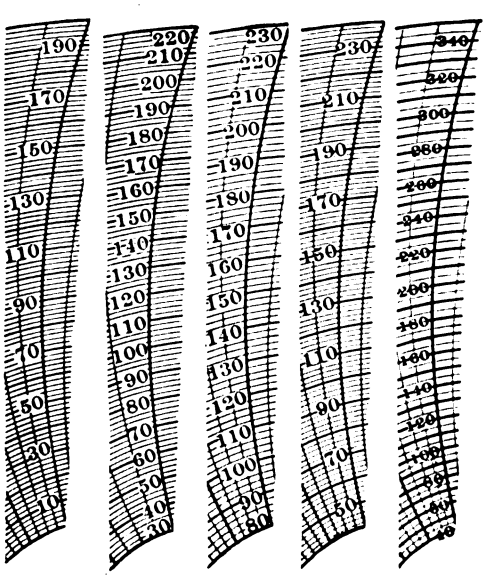

FIG. 8. SCHAEFFER & BUDENBERG CHARTS

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Figure 3 is a complete engine log from which the last three items may be omitted for routine records. A log of total quantities for a condensing plant is shown in brief by Figure 4, which may be used as a basis for reckoning the fuel cost of power and comparing daily performance of the plant as a whole.

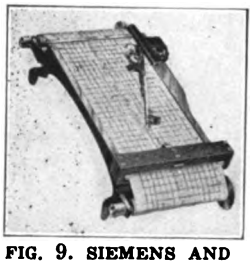

FIG. 9. SIEMENS AND HALSKE INTEGRATING PLANIMETER RECORDS

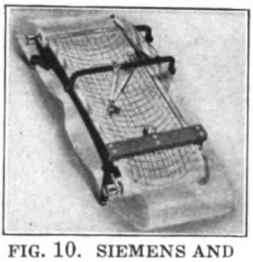

FIG. 10. SIEMENS AND HALSKE INTEGRATING PLANIMETER FOR COVERED ORDINATE RECORDS

It should be observed that a good deal of the data usually entered on the cards or books of a power-accounting system may be noted on the autographic records instead. The latter also include certain information which, without the use of recording instruments, is hand written on data sheets. For instance, the time each unit is in operation is ordinarily kept by noting the starting and stopping in figures, or by drawing a line in a time column headed with the number of the unit. A recording wattmeter, or a water-flow meter on the condensate, would serve the purpose without clerical work.

It is a good arrangement to file together all the autographic records from each unit, so that the performance of that unit at any time may be compared in detail with its past performance. Some of the records apply to a number of units in common, such as those of pressure and of feedwater temperature; these may be separately filed.

Disc-type charts lend themselves readily to filing. Figures 5 and 6 show convenient arrangements for the purpose, which may be placed horizontally in a drawer or on a shelf, or may be fastened to a wall. Each day's records may be kept separate from the rest by a tag slipped over the file spindle and projecting a trifle beyond the circumference of the largest chart, the projecting end to be dated and used for an index. It may be that a day's records for a given unit contain some drum-type charts. These may be neatly filed with the circular ones by perforating them uniformly for the file spindle. If drum charts only are to be filed, a convenient method is to use drawers built to fit them and marked on the outside to indicate their contents.

Integrating and Averaging

A classification of the various forms of recorder charts in common use will disclose the following, it being understood that the co-ordinates measuring time are always referred to as abscissas, and those indicating the quantity sought as ordinates:

Disc Charts

I. Radial ordinates, uniform scale.

II. Circular ordinates, uniform scale.

III. Circular ordinates, non-uniform scale.

Drum Charts

IV. Rectangular ordinates, uniform scale.

V. Rectangular ordinates, non-uniform scale.

VI. Circular ordinates, uniform scale.

VII. Circular ordinates, non-uniform scale.

Figures 7 and 8 show examples of these several forms.

Most of the flow-rate recorders include an automatic integrator and register, thereby obviating manual work. With such instruments, it is only necessary to record on the chart

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the initial and final register-readings for the period of the chart, the difference between them being the total flow. Knowing this, the average rate is readily figured without the use of a hand-operated planimeter. When the chart shows periods of wide difference, such as might ensue from the carefulness of one operative and the inattention of another, it becomes desirable to find totals and averages corresponding to these intermediate periods, for which the readings of the register may not have been taken. In this case a hand-operated planimeter or some process of mensuration must be resorted to. Furthermore, many of the records, such as of CO_2 percentages, pressures, temperatures, and the like, being simple quantities and not rates, are not to be totaled but are to be averaged. This involves again the use of the hand planimeter or of mensuration.

As a rule some special form of planimeter must be used, according to the character of the co-ordinates of the record to be integrated or averaged; but in certain cases the ordinary integrating planimeter may be employed for approximate results, and for others it is exact.

For records on rectangular, uniform-ordinate charts the ordinary planimeter is, of course, applicable. To get totals, the area is found in square inches and then multiplied by the scale of area to find the result in terms of the metered quantity. Or, if the planimeter has an adjustable arm, the final result may be read direct by making this arm equal to

$$\frac{\text{Number of graduations on planimeter wheel}}{\pi \times d \times M \times N}$$

in which

d = diameter of wheel in inches,

M = number of wheel graduations selected to represent one unit or multiple unit of the metered quantity,

N = number of these units represented by one square inch on the chart.

To get averages from rectangular, uniform records of simple quantities, it is an easy matter to find the mean height in inches and lay this off from the base line of the record so as to determine the corresponding scale units.

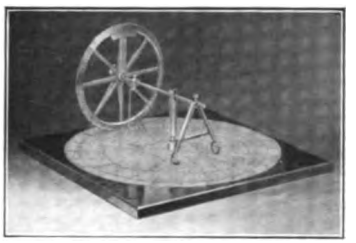

FIG. 11. BRISTOL-DURAND AVERAGING INSTRUMENT

The special planimeter shown by Figure 9 furnishes an improvement upon the ordinary type when used on the form of charts under consideration, since with it only the autographic curve need be traced, and not the whole area under the curve. The principle of this instrument depends upon the condition that the pivot of the planimeter arm travel in a right line directly over the base line of the record.

When rectangular charts have non-uniform ordinates, these methods are not applicable. In some cases, however, approximate results may be had with the ordinary planimeter, the degree of the approximation depending upon the amount of variation in the scale of ordinates and the constancy of the record. In *V*, Figure 7, for instance, a rough result could be obtained by finding the mean height in inches and laying this off from the base line. When records of this sort show periods of approximate constancy, the periods may be separately averaged in this way and a time mean of the results then calculated. Otherwise one must resort to mensuration.

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These considerations apply also to drum charts with curved ordinates. In general curved-ordinate charts, whether drum or disc, cannot have strictly uniform spacing, since at best the ordinates are spaced by the projections of uniform divisions on an arc. However, they are in most cases sensibly uniform, provided the pen arm swings through an angle proportional to the measured quantity. If the arc has but little curvature, approximate results may be had by the use of the ordinary planimeter, especially if the record lies in the middle of the chart where the spacing is more nearly uniform (see *VI*, Figure 7). Aside from the error introduced by scale variation, there is inaccuracy due to the distortion of the record from the rectilinear components which must be assumed when the ordinary planimeter is applied.

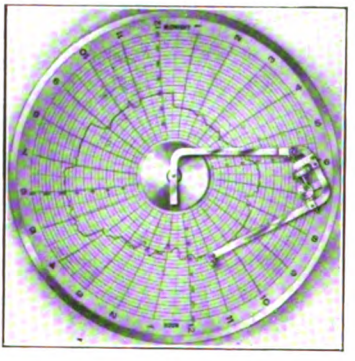

FIG. 12. BUILDER'S IRON FOUNDRY INTEGRATING PLANIMETER

The special planimeter illustrated by Figure 10 avoids these errors and is strictly applicable to drum charts with sensibly uniform, curved ordinates. It is operated in the same manner as is the planimeter of Figure 9.

Circular charts are readily averaged with the form of planimeter represented by Figure 11. This is to be adjusted to the base circle of the chart and then the average in scale units may be obtained by multiplying by a constant the difference between initial and final readings when the record is traversed. It yields a theoretically exact result for either radial or curved ordinates, provided they are sensibly uniform.

Another form of radial planimeter, suitable for integrating rate records, is shown by Figure 12. It is arranged to read zero when the tracing point traverses the base circle; any other path of the tracing point causes the planimeter wheel to move in proportion to the product of rate and time.

For non-uniform ordinates, there is in general no planimeter available, but in the case of the General Electric flow-meter charts, which have ordinates varying as the square of the velocity of flow (*III*, Figure 7), there has been devised an appropriate planimeter giving accurate results. This is illustrated by Figure 13. In operation and general principle it is similar to the instrument just described, its distinguishing feature being the cam which provides for the variable scale of the flow-chart ordinates.

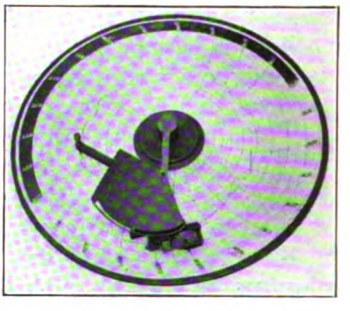

FIG. 13. G.-E. RADIAL FLOW METER FOR NON-UNIFORM ORDINATE RECORDS

This cam changes the angular position of the record wheel when the tracing point moves radially from the chart center, thus decreasing the slipping motion of the wheel and increasing its rolling motion in proportion not only to the path of the tracing point but also to the larger scale.

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The mensuration method of averaging or totaling consists simply of transferring from the record a series of values corresponding to equal time-intervals and averaging these, a somewhat laborious process and one whose accuracy is dependent upon the number of values taken.

When records show very uniform conditions, such as may be maintained in relation to steam pressure, feed-water temperature and the like, an eye estimate of the average will suffice for routine procedure provided that the practice be not abused. The purpose to which a measurement is applied is always the criterion of the care necessary in making it. It is a waste of time to use a planimeter to average a feed-water-temperature record, for instance, and express the average to a tenth of a degree, when the purpose of the measurement is to find factor of evaporation. If the average can be estimated by eye to within 10 degrees, it is sufficient for this purpose, because an error of 10 degrees would figure about 1 per cent of error in the factor of evaporation. If the purpose were to test the performance of a feed-water heater, however, the average temperature should be obtained to within about 1½ degrees to secure the same percentage of accuracy.

The ordinary integrating planimeter is not appropriate to circular records, for the reason that their area is proportional not to the mean ordinate (radius) as with rectangular records, but to the square of the mean ordinate. Nevertheless, this instrument may be applied to averaging such records approximately, if they do not vary greatly. The procedure is to find the area in square inches, divide this by π, and take the square root of the quotient. The result is approximately the average radius of the record in inches, which may then be measured from the chart center to determine the corresponding quantity in scale units. The result is approximate, since it is not the arithmetical mean but the square root of the mean of the squares of the radii. These two values are very close, however, except in cases of extreme variation of the record. To obtain the average of a portion only of the record, the area of the corresponding sector only is found and this divided by π and the fraction of 360 degrees represented by the sector; the procedure otherwise is the same. This method was related in detail in *Power*, Aug. 19, 1913, by the writer.

In Conclusion

The various types of recorders necessary to a reasonably complete equipment may strike the cost-considering reader as a staggering array. When it is considered, however, that a 10 per cent waste, the very least in non-metering plants, in a 500-horsepower boiler operating on the average at half load amounts to about $1,800 a year, and that leaks in pipes or valves through areas aggregating one square inch (even when such leaks exist only half the time) waste about $8,000 a year, let alone other sources of waste, the idea of figuring the cost, depreciation, etc., of recording instruments against the possible saving becomes ridiculous—the answer is self-evident. A business concern might just as well attempt to save money by throwing out its bookkeepers as a power plant by omitting recorders. The only necessity to the saving of the expense of these instruments in a brief time is that their records be intelligently studied and acted upon as herein emphasized. This requirement is slowly being realized to the extent that, in the near future, the recording of power plant operations will be universal.

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DISTRIBUTING OVERHEAD EXPENSE

By Nicholas Thiel Ficker

VII. THE MACHINE UNIT SYSTEM

In the previous chapters of this series, which began in the June issue, Mr. Ficker has analyzed all of the elements of manufacturing expense, and now takes up the question of distribution to production costs. The main part of the expense has been shown to be "machine expense." In this chapter he describes in detail the "machine unit system" of distribution, and next month he will show how the faults of the system should be remedied to meet existing conditions.—THE EDITORS.

THE distribution of the machine expense portion of manufacturing expense by means of an hourly rate of expense loading chargeable against the various productive machines and benches comprising a shop, is known as the Machine Unit System. It is accomplished by dividing and sub-dividing the normal yearly machine expense by means of analysis and estimate until all of this expense has been assessed directly against the various productive units. This unit expense is then reduced to a rate per machine hour by dividing it by the estimated number of hours of operation per year for each machine.

The machine unit system of expense distribution varies from the commonly used "percentage of labor method," in that it distinguishes between the costs of operating the various machine types, and establishes a relation between the output of each machine unit and its operating cost. The fault found with the machine unit method is that it is based too largely on estimate, and that it depends on what is known as a "supplementary rate" to make it check with the actual manufacturing expense for any period. Whether or not this criticism is justifiable, and if so what changes must be made to remedy these faults, will be discussed in the next chapter. However, in order to understand more fully what this criticism is based on, let us first consider the machine unit system in its present form.

The first step in connection with the installation of this system consists of determining the *normal* machine expense which is to be distributed. This is derived from a study of the various divisions of manufacturing expense for past years, such as administration, power, rent, fixed charges, tool expense, etc., as analyzed in preceding chapters. The term "normal," as here used, may be defined as the amount of expense which past experience and present knowledge of future conditions would warrant as being applicable under normal shop activity. This normal expense should be neither high nor low, but a safe basis on which costs can be computed. This will bring forcibly to mind the futility of trying to apply machine rates in plants where manufacturing expense charges have been kept in a haphazard manner. Accurate records of past performances are absolutely necessary, and the machine rate should not be attempted until sufficient reliable data is available for use as a basis of estimate. A study of the manufacturing expense should be made at least once a year and revisions made when found warranted. Changes in prices of ex-

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pense materials and supplies, or changes in the wages paid to expense labor, such as millwrights, men setting up machines, etc., directly effect the normal expense and must therefore be carefully analyzed with regard to their influence on normal figures.

Turret Lathes		Size of Stock
"	"	½ in.x10 in. to 1¼ in.x10 in.
"	"	1¾ in.x 8 in. to 2½ in.x12 in.
"	"	(Heavy Type) 2 in.x24 in.
"	"	" " 3 in.x36 in.
"	"	" " 12 in.x40 in.

The second step comprises the standardization of the various machine types by classification, according to arbitrary standards. For example, in a plant known to the writer where the machine unit system is in operation, the productive machine classifications were standardized as follows:—

MAIN CLASSIFICATIONS
- Lathes
- Screw machines and miscellaneous lathe types
- Milling machines
- Drill presses
- Grinders
- Buffers and polishers
- Tappers
- Punch presses
- Shears
- Metal planers
- Hammers
- Metal saws
- Sheet metal rollers and formers
- Furnaces, forges, and annealing machines
- Anvils and surface plates
- Jointers and planers
- Molders and shapers
- Sanders
- Wood saws
- Mortising and tenoning machines
- Bench work

Each type of productive machine is sub-divided according to its functions. For example, lathes were sub-classified as follows:—

Lathes:—Turret
Engine
Tool makers and precision
Rapid reduction
Hand and speed
Wood turning
Backing off
Gear cutting
Gap engine

A detail classification of each machine type is then made according to capacity, as follows:—

Swing	Length of Bed	Classification
10 in. to 14 in.	4 ft. to 7 ft.	LA
15 in. to 18 in.	7 ft. to 10 ft.	LB
12 in. to 16 in.	8 ft.	LC
19½ in	9 ft.	LD
21 in	9 ft.	LE

In order to make possible a detailed classification of machines similar to that above, each machine should be assigned a number as soon as installed, and a plate bearing this number should be affixed permanently to some conspicuous part of the machine so that it may be easily distinguishable. A card should then be made out showing the machine number, manufacturers name, type number, size, date purchased, purchase price, location, etc., together with the classification letters for that type of machine. These classification letters should then be stamped on a separate plate from that used to designate the machine number and affixed to the machine in the same manner. The advisability of using separate plates for the classification and number will be found when changes to the classification plates are necessitated owing to errors made in assigning these classifications. By this method the classification plate can be detached without disturbing the number plate, and in this way the confusion resulting from the simultaneous removal of a number of plates bearing the numbers of different machines is eliminated.

The machine equipment may be arbitrarily divided into two distinct classes: Standard type machines, and miscellaneous type machines respectively. In the former class would be included all of such standard machine tools as lathes, punch presses, milling machines, drill presses, etc., while the latter class would include such equipment as ovens and furnaces, tanks, kettles, pots, vats, motors driv-

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ing standard type machines, testing apparatus, etc. As defined in Chapter III, miscellaneous machinery includes those non-portable fixtures which are used in direct production and which are accessible, therefore, against the work which is performed, either directly or on a pro-rata basis.

From a production analysis, the machine equipment consists of four parts: Productive machines, non-productive machines, productive benches, and non-productive benches. A "productive machine" may be defined as a machine used by a workman in actual manufacturing and against which time is turned in for the work done at such a place. A "non-productive machine" is an auxiliary used in connection with a productive machine. It includes such equipment as water-tool grinders, etc., whose time of operation cannot be reported against jobs on time tickets. A "productive bench" is a bench, or even floor space, used by a workman in actual manufacturing and against which time is turned in for the work done at such a place. A "non-productive bench" is one used as an auxiliary to a machine, as, for example, a bench used for holding tools or work, or for small operations in connection with the machine where all the time is turned in against it.

Having thus established a distinction between the productive and non-productive units, the next step is that of distributing the normal manufacturing expense to production centers. This expense must be analyzed and segregated; first, by the general divisions of the manufacturing organization; then by departments, and finally by productive units. Going back, therefore, to the manufacturing expense which has been under consideration in preceding chapters, we find this to have been divided as follows:—

MANUFACTURING EXPENSE

Administration and clerical		$49,419.90
Power		22,632.30
Rent		54,363.20
Tool		156,402.05
Fixed Charges:—		
Depreciation	$87,943.18	
Insurance	359.31	
Taxes	1,054.74	
		$89,357.23
Material		35,128.07
Unclassified		1,209.71
Idle Labor		16,487.54
Grand Total Manufacturing Expense		$425,000.00

The above expense items represent practically only the direct charges as made during the year, and will be affected, somewhat, by transfers which have to be made first between these divisions of expense for service and then to machine and material expense respectively. These charges if apportioned on the basis of their analysis in former chapters would then appear as follows:—

Class of Expense	Chargeable to machine expense	Chargeable to material expense	Chargeable to other than shop expense	Total Expense
Administration and Clerical	$50,967.39	$673,07	$125.29	$51,765.75
Power	22,175.30	1,195.53	.....	23,370.83
Rent	17,175.53	11,213.55	22,385.54*	50,774.62
Tool	156,402.05	.....	.....	156,402.05
Fixed Charges	80,357.00	9,000.23	.....	89,357.23
Material (direct Charges to Material Expense)	.....	35,128.07	.....	35,128.07
Idle Labor	16,487.54	.....	.....	16,487.54
Unclassified	1,209.71	.....	.....	1,209.71
Engineering and Drafting	504.20	.....	.....	504.20
Total	$345,278.72	$57,210.45	$22,510,83	$425,000.00

* Represents charge for 38.791 sq. feet of surplus floor space:—($19.911.43) plus charge to shipping expense for space occupied by Shipping Dept. ($2,474.11), or a total of $22,385.54. See Chapter 5.

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An inspection of the above figures will show that the amount of manufacturing expense chargeable to machine expense is $345,278.72, leaving a balance of $57,210.45 to be assessed as a material expense loading against production costs. This machine expense, as shown above, is made up of various kinds of expense, each of which must now be distributed to production centers according to different units. For analytical purposes, let us consider the expense figures used herewith as representing the manufacturing expense which has been obtained as "normal." This expense, together with the units and rates of distribution, would then be shown as follows:—

UNIT ANALYSIS OF NORMAL MACHINE EXPENSE

Machine Expense	Amount	Total Expense	Rate	Units	Basis of Distribution
Administration ..		$50,967.39	$50.97	1,000	Productive Employees.
Power:—					
Compressed Air	$3,236.83		.130 per M.	24,900,000	Cu. ft. of free air
Elec. Current..	16,747.31		.024	693,522	Kilowatt hours.
Steam	2,191.16	$22,175.30	.414 per M.	5,292,657	Pounds of steam
Rent		$17,175.53	.5775	29,742	Sq. ft. of floor space.
Tool Expense....		$156,402.05		$156,402.05	Production centers.
Fixed Charges:—					
Depreciation ..	$79,087.30				
Insurance	323.13				
Taxes	946.57	$80,357.00	10%	$80,357.00	Face values
Idle Labor.....		$16,487.54		$16,487.54	To dept. on basis of productive labor. To machines on basis of normal hours of operation
Unclassified		$1,209.71		$1,209.71	Prorated on basis of departmental expenses
Engrg. & Dftg*..		$504.20		$504.20	Prorated on basis of distribution of tool expense
Total Machine Expense		$345,278.72			

* Engineering and drafting is here interpreted to pertain to the designing and experimenting in connection with the machine and tool equipment. If this work involves a large and separate organization, the expense incidental thereto can be applied to costs of production as a separate loading known as "Engineering Expense." However in most plants the distribution of this expense on the basis of the distribution of Tool Expense is sufficiently practicable.

Having assembled the machine expense by classifications, rates, and units of distribution, as here shown, we are now ready to consider each kind of expense somewhat more in detail:—

ADMINISTRATION: — Administration Expense may be arbitrarily divided into two parts (a) "General Shop Administration" and (b) "Departmental Administration" expense respectively.

(a) The "general" administration expense is made up of the administration and clerical expenses of the shop organization, which cannot be assessed directly against any of the manufacturing departments. It includes the salaries of the shop superintendent and his assistants, salaries of employment, cost, and payroll departments, stationery, telegrams, traveling expenses of shop executives, etc.

(b) The "departmental" administration expense is more or less self-explanatory, as it consists of the salaries of departmental foremen, fore-

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men's clerks, and any other administration expense which can be assessed against specific manufacturing departments.

Administration expense is distributable on the basis of productive man-hours, determined by multiplying the average number of productive employees by the normal yearly working hours per employee. On an average of fifty hours per week, these hours would equal 2,600 per man per year. It will be seen, therefore, that the "general" administration rate will be the same per employee for all departments, while the "departmental" rate will vary according to the administration expense of each separate department. Assuming, therefore, that on analysis the administration expense of $50,967.39, which we have used, is divided in a ratio of one-third to "general" and two-thirds to "departmental," the expense figures would be:—

General Shop Administration Expense	$16,989.13
Departmental Administration Expense	33,978.26
Total	$50,967.39

Reducing the "general" administration expense to a rate per man, by dividing it by the number of productive employees (1,000) and then further reducing this rate ($16.99) to a rate per man hour by dividing it by the normal hours per year (2,600), this rate is found to be $0.0065 per man hour. The "departmental" expense of $33,978.26 is, however, made up of a total of different department's administration expenses, and must, therefore, be distributed by dividing each department's administration expense by its productive man hours as follows:—

Department	Number of Employes	Departmental Administration Expense	Productive Man Hours	Rate per Man Hour
A.	100	$4,000.00	260,000	$0.0154
B.	200	7,000.00	520,000	0.0135
C.	300	9,000.00	780,000	0.0115
D.	400	13,978.26	1,040,000	0.0135
Total	1,000	$33,978.26	2,600,000	$0.0131 (not used)

Adding the "general" administration rate to the rate of each department, the total rate per man hour for the respective departments would then be

Department	Departmental Rate	General Rate	Final Administration Rate per Productive Man Hour
A.	$.0154	$.0065	$.0219
B.	.0135	.0065	.0200
C.	.0115	.0065	.0180
D.	.0135	.0065	.0200

POWER:—Power Expense is distributed in proportion to the amount of steam, electric current, or compressed air used by each machine or bench. This distribution is based on actual tests made on each type of machine under working conditions, or on estimates where such tests cannot be made.

In plants where a considerable part of the machine-tool equipment is operated directly by motors, an allowance should be made in the rate per kilowatt hour for power so used as against power sent through the general transmission (line shafting) system. This rate for direct motor drive would be based on the current distributing expense figures, and the regular transmitted power rate on the transmission expense figures. The rate for power transmitted would, therefore,

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be somewhat higher than that for current distributed, due to the additional expense of operating the line shafting. By referring back to Chapter IV on "power expense," it will be seen that the maintenance of this transmission system amounted to $3,111.10. If we assume that one-third of the 693,522 kilowatt hours is distributed directly to machines, and two-thirds transmitted through line shafting, we can obtain both the costs and rates per kilowatt hour for each method of current conveyance, as follows: The total expense for electric current, distributed and transmitted, is $16,747.31 (See Unit Analysis table), of which the direct charges to transmission expense, as per power expense analysis in Chapter IV, are $3,111.10, leaving a net distributing expense of $13,636.21 to be closed out, one-third ($4,545.40) to distributing expense, and two-thirds ($9,090.81) to transmission expense, making a total transmission expense of ($9,090.81 + $3,111.10) $12,201.91. To find the rates per kilowatt hour for distribution and transmission, we would proceed as follows: The total current is 693,522 kilowatt hours, one-third of which, 231,174, is distributed, and two-thirds, 462,348, is transmitted; the rate for distributing current is, therefore, 4,545.40 ÷ 231,174, or $0.0197 per kilowatt hour, and the rate for transmitting current is 12,201.91 ÷ 462,348, or $0.0264 per kilowatt hour.

Before proceeding to distribute power expense, a list of all productive and non-productive machines in each department should be compiled, showing the class letters, description of each type of machine, and the number of machines covered by the description. A list should also be compiled of distinctively different kinds of "productive bench work," with a description of the general line of work done. Non-productive machines should be listed by departments, with a record in each case of the number, description, and classification of the productive machine or bench against which all of the expense of this non-productive machine is chargeable. A practical method of assembling this data together with the additional information required with regard to floor space, hours of operation, etc., is shown herewith, separate sheets being used for listing productive and non-productive machinery respectively.

PRODUCTIVE
NON-PRODUCTIVE MACHINERY IN.....DEPT.

Machine Number	Description	Cost			Power			Floor Space	Yearly Hours	Machine Class
		Mach.	Motor	Total	Watts	Drive	K.W.Hrs			
156	Embossing Special Mch.	$150.00	$50.00	$200.00	253	c/d	506	24 Sq. ft.	2,000	A B C D

Where a number of machines of different types are being operated from the same line shafting, the line-shaft load should be assessed against the respective machines on the line in proportion to their watt-hour consumption under operating conditions. The "Power Test Report" form, shown on the following page, has been used by the writer in making machine power tests and will give a general idea of the method of procedure to be followed.

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MACHINE POWER TEST

DESCRIPTION OF MACHINE:

OUR SHOP NO. ABCD-156 KIND OF MACHINE Embossing Machine
BUILDERS NAME Special Machine TYPE NO. —
MISC. This machine was built in our shop
LOCATION - Department #23 - East Wing

POWER TEST:

MACHINE DRIVEN BY MOTOR (BELTED OR DIRECT) OR LINE SHAFT ✓
MAIN BELT Leather WIDTH 2" THICKNESS Single
DRIVING PULLEY (ON MACHINE) gear. DIA. R. P. M. 72
(SKETCH ROUGHLY ON BACK OF THIS SHEET METHOD OF BELTING TEST MOTOR)

~~MATERIAL~~ Motor Test ~~WORKED ON~~	AMMETER READINGS				VOLTS	NET POWER IN WATTS	PROPOR. LINE SHAFT LOAD IN WATTS	TOTAL POWER IN WATTS TO MACH.
	MOTOR LIGHT		MOTOR LOADED					
	START	RUN	START	RUN				
Machine Light:-								
Armature			9.4	1.5	55			83
Field			1.2	1.2	110			132
Total Watts								215
Machine Loaded:-								
Armature			9.8	2.2	55			121
Field			1.2	1.2	110			132
Total Watts								253
				C ×	V	=		W

NOTES Operated by 3/8 HP motor, type EI-CB, 110 Volts, 13.1 Amperes
r.p.m. 300.

TESTED BY W.S.M. APPROVED

DATE

FORM FOR MAKING POWER TEST REPORTS

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In this instance the unit tested was a special machine geared to and driven by a three-eighth horsepower motor. The test showed a power consumption of 253 watt hours and, as the machine was direct connected, the power expense rate used was that for "current distributed" ($0.0197 per kilowatt hour). Assuming the yearly hours of operation of this machine to be 2,000, the power expense chargeable thereto would be

$$253 \times 2000 \times \frac{.0197}{1000} = \$9.97.$$

One of the objects of making power tests is to establish a relation between specific grades of work done on different types of machines. Certain rules must therefore be observed in making these tests. For example, when making tests on lathes the following information is required: First, size of cut taken, 1/16, 3/16, 5/16, or 7/16 inches; and second, speed of operation—low, medium, or high.

General points to be observed on other machines are as follows:—

Drill Presses—The cubic inches of metal removed per minute.

Punch Presses—The revolutions per minute of fly wheel and number of strokes.

Milling Machines—The cubic inches of metal removed and the speed. (Where traverse is controlled by hand, a stop watch should be used to determine exact time of removing a certain number of cubic inches of metal.)

Shapers and Planers—The cubic inches of metal removed per minute.

Squaring Shears—The square inches of metal sheared per minute.

Tappers—The size of hole tapped and the speed.

Grinders—The speed and pressure applied by operator.

Tests made on types of machines other than those listed above, must be made in each case along specific lines governed by the particular type of machine under consideration. Stock used in making these tests should be similar to that worked on under average manufacturing conditions. The making of these power tests should be carried out under the supervision of an electrical engineer who will see that all connections are properly made. Many valuable recording instruments are often destroyed through carelessness in connecting up ammeters and voltmeters used in making power tests, and hence all possible safeguards should be used in order to avoid this useless expense.

RENT EXPENSE:—This expense is distributed and assessed against machines, benches, and erection areas of both productive and non-productive classification at a uniform rate per square foot according to the space occupied. These areas should be carefully measured, and should include the projected obstructive area for each machine and any additional space necessary for its proper operation and maintenance. The total of all floor areas so assessed must equal the floor space charged to machine expense, any vacant space in manufacturing departments being divided proportionately among all machines, benches, erection areas, etc. The proportionate amount for rent expense can then be charged to each machine on the basis of these areas at the established rate per square foot. (See Rent Expense, Chapter V).

TOOL EXPENSE:—This expense is first distributed by departments and then, by dividing and sub-dividing it by analysis and estimate, it is finally charged against the benches and machines in each department of the shop. Depreciation of small tools is assessed against each department on the basis of face values of the small tool account, found by analysis. Supplies should be similarly distributed to departments, on the basis of amounts furnished each department and then to machines and benches by estimates of quantity used. Salaries of tool in-

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spectors, tool draughtsmen, and any other expenses incidental to tool stock, are distributable according to services rendered. If data pertaining thereto is not available, then this expense should be distributed to departments on the basis of face values of the machine and tool equipment in each, and then by estimate to the machines and benches. Any other classifications of tool expense must be analyzed and distributed until they are finally assessed against machines and benches. The following distribution sheet shows how tool expense is so distributed:—

SCREW MACHINE DEPARTMENT

Tool Expense Distribution Sheet

No.	Classification Description	1-E. W. Main Grinding Machine	11 P & W Turret Lathes 1½ x 18	3 Water Tool Grinders	4 Universal Tool Grinders
	Belting for machines	$ .46	$30.16	1.37	$1.86
	Changes to small tools and (tool) shop fixtures	2.32	16.35	2.36	1.24
	Changes to machinery	.10	1.11	.30	.40
	Depreciation of tools and shop fixtures	229.90	1,608.11	230.12	115.28
	Insurance on " " " "	.10	1.11	.32	.40
	Taxes " " " " "	.07	.75	.20	.27
	Repairs to machinery	15.12	166.32	45.35	60.50
	" " tools	30.11	210.50	30.11	15.05
	" " patterns	.....	.....	.....	.....
	Salaries—clerks in tool stock rooms	9.05	68.38	9.05	4.52
	" tool inspectors	4.94	34.58	4.94	2.47
	" machine oilers	5.78	40.50	5.78	2.89
	" setting-up machines for operators	95.60	47.85	23.85	65.60
	" setting-up new machines	9.02	90.30	25.28	32.45
	Stationery, supplies, waste, oils, etc	.77	8.49	2.31	3.23
	Water (other than for power or rent expense)	.....	.....	.....	.....
	Services Charges — Administration, Power, Rent. Charged separately on Summary Sheet.				
	Total Tool Expense	$403.34	$2,324.51	$381.34	$306.16

FIXED CHARGES:—Depreciation, insurance, and tax charges are assessed directly against each machine in the factory on the basis of face values. In the specimen analysis on page 393, the rate used for all fixed charges was found to be 10 per cent; therefore 10 per cent of the face value of each machine must be added to cover this expense.

IDLE LABOR EXPENSE:—The term "idle labor expense" as here used should not be construed as meaning idle machine hours. It is the cost of the wages of productive employees which have not been charged, for some reason or other, to production orders. For example, in a shop where the wages of men classified on the pay roll as productive employees might amount to $5,000 a month, the cost summary of shop orders made at the end of a certain month might show that only $4,500 of this amount had been charged to production work. The difference of $500 would there-

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fore be chargeable to manufacturing expense as "idle labor expense." It is made up, under average manufacturing conditions, of time lost in reporting to foremen or time-clerks between jobs, of waiting for assignments of new work, of time lost in washing up, or any other causes, justifiable or not, which keep the workmen away from actual production work. Strictly classified, this expense should be called "non-productive labor," but as this is the term applied to expense labor such as sweepers, etc., the term "idle labor expense" as here used is probably more easily interpreted. For some reason or other this expense is usually neglected, in connection with arriving at normal manufacturing expense figures. It should, however, be given as much if not more consideration than any other charge to manufacturing expense, as it represents a waste traceable directly to the shop organization. The manufacturing branch of a company is not usually responsible for the idle machine hours due to slackness in business, but it does control and is, therefore, responsible for the factor of "idle labor expense" incurred through its own inefficiency. While, on analysis, this expense might be shown as being chargeable to certain departments of the shop, it would not necessarily follow that these departments were the ones responsible. Any of the causes which have been cited, with the possible exception of time lost in "washing up," might be due to other departments than those against which the charges appear; hence, the distribution of this expense by departments should be averaged in proportion to the productive labor, and then charged to the machines on the basis of normal hours of operation.

UNCLASSIFIED EXPENSE:—This is assessable on the basis of the proportion of manufacturing expense charges against each department and machine. Engineering and drafting expense, as here considered and as amplified in the foot note under the "Unit Analysis of Normal Machine Expense," is assessable to production centers on the basis of tool expense charges.

Having established a basis of distribution for all of the expense classifications comprising "machine expense," these charges must now be assembled in order to arrive at a rate per hour of operation for each machine class. It will be remembered that all expense distributed has been asssessed against both productive and non-productive machines alike. In this way the cost of operating non-productive machines is kept distinct from the cost of operating the productive units. The non-productive machine expense is, however, charged as one item to the productive machines or machines for whose benefit it is operated. The form on following page shows a practical method of assembling machine unit data.

The machine rate of $0.09 per hour, found for the "1-Spindle Drill Presses" on the specimen summary sheet, would, if applied to shop costs for 1,200 hours of operation, absorb all of the machine expense of $81.34 chargeable against this type of machine. Other machines of different types having different rates per hour would in like manner absorb all of their machine expense providing they were operated to normal capacity. In this way all of the machine expense would be assessed to costs of production each year. There remains for consideration, however, the fact that these machines may be operated either above or below that degree of shop activity which has been considered as normal and hence a variation will immediately exist between the current expense and the normal ex-

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SUMMARY OF PRODUCTIVE MACHINE UNIT EXPENSE

Description of machine.....P. & W. 1-Spindle Drill Presses
Machine classification....."D.A." Department (A) Drilling
Number of machines in class..... 2

1	Administration:		
	General rate per hour per man.....	$0.0065	
	Departmental rate per hour per man.....	0.0154	
	Total Administration Rate per Hour per man.....	0.0219	
2	Power: Kind—Currrent Distributed. Units per year—321 Kilowatt Hours Rate per unit—.0197. Total	$6.32	$3.16
3	Rent: Area 24 square feet. Annual rate per square foot $.5775	13.86	6.93
4	Tool Expense	75.00	37.50
5	Fixed Charges: Face value $88.00. Annual rate 10 per cent	8.80	4.40
6	Idle Labor Expense.....	12.00	6.00
7	Unclassified Expense	28.00	14.00
8	Non-Productive Machine Expense chargeable hereto.....	18.70	9.35
9	Total Machine Expense per year.....	$162.68	$81.34
10	Normal Annual Hours of Operation.....		1,200
	Summary:		
11	Rate per Hour.....		$0.068
12	Administration Rate per Hour (See 1 above).....		$0.022
	Machine Unit Rate per Hour of Operation.....		$0.09

Note: In such instances where an operator runs more than one machine the Administration Rate will be divided proportionately per hour.

pense applied through the machine rates. This difference is known as the "Current Variation" and introduces what is known as the supplementary rate of loading which must be either added to or subtracted from the standard (normal) costs to make them agree with the actual expenditures. In the next chapter the writer will discuss the theory on which the supplementary rate is based, analyze its effect in practical application and criticise its influence on operating conditions. Manufacturing is becoming more and more a question of specialization and with this specialization has come a realization that some of the cost methods which were considered reasonable ten years ago do not fit today. These questions will be taken up in the following chapter with a view toward remedying present methods so as to meet conditions that exist today in the manufacturing field.

To be concluded

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HANDLING MATERIALS IN MANUFACTURING PLANTS

By Robert L. Streeter

II. OVERHEAD CRANES, WALL CRANES, AND JIB CRANES

Last month Mr. Streeter told about the varieties and capacities of heavy equipment for unloading bulk material upon its arrival at the manufacturing plant. In the following pages he shows how heavy material is handled during the process of manufacture. Later chapters will treat more especially of the methods for carrying smaller pieces from place to place in the shop. While it is not likely that any single plant will have installed all the machinery described in these articles, yet every plant will have use for one or more of the devices in surmounting the labor problem.—THE EDITORS.

OF all mechanisms used for this work none are more closely patterned after man than the crane. For picking up and transporting small and light objects short distances, nothing is so convenient as the human hands, and for moving large and weighty materials, no handling contrivance is superior to the crane. And the larger and heavier objects become, the greater the efficiency of this class of equipment.

It is the immense superiority of the crane for handling heavy articles that has left it without a rival in the metal-working industry where it is found in its greatest variety and highest development. In fact, so important is the crane equipment in this line of manufacture, particularly in shops that build heavy machinery, like boilers, locomotives, dynamos and motors, engines, machine tools, etc., that it is found to take precedence over all else in the design of the buildings. The writer recently made a visit to the shops of one of our largest manufacturers of electrical equipment. While inspecting the cranes at that plant it was pointed out to him that every building of the plant, and there are many of them, contains two extra heavy roof trusses put there solely for the purpose of affording a means for hoisting the overhead cranes into place.

By crane is meant any type of mechanism for moving material operating by picking up and carrying; and in this respect it is unique, for almost every other similar device is capable only of carrying. To the fact that the crane is both a lifter and a transporter is due its high efficiency.

With the above definition in mind we might classify cranes into two general classes: first, those whose area of action is limited only by the extent of their tracks; and second, those whose area of action is limited by the size of the crane itself. Into the first class would fall overhead traveling cranes, monorail cranes or telphers, and wall cranes. In the latter are included jib cranes, pillar cranes, and various types of stationary cranes used for special work.

There is another mechanism that is often included in the crane category. This is the hoist, which, strictly speaking, is not a crane, as it is used for lifting alone. It is true that every crane is a hoist, but equally true that a hoist is not necessarily a

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crane. There are certain classes of hoists that can be used with or without cranes which will be discussed in a later paper along with the telpher.

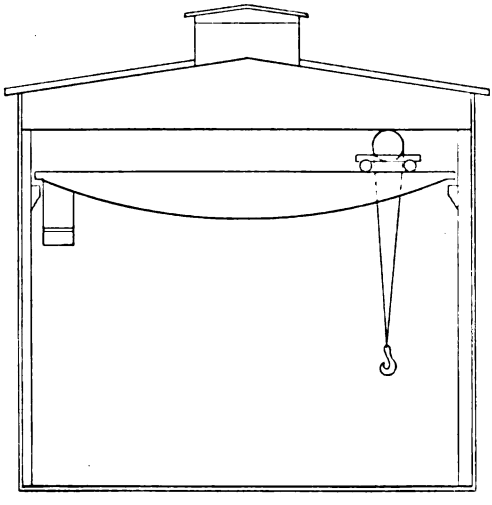

FIG. 1. ONE OVERHEAD CRANE REACHING CLEAR ACROSS SHOP

This paper will deal only with overhead traveling, jib, pillar, wall, and some special types of cranes.

THE OVERHEAD TRAVELING CRANE

This machine consists essentially of a bridge or girder running on high tracks, a trolley that traverses the bridge from end to end, and the hoisting mechanism with the necessary brakes. Many cranes of large capacity have two separate hoists, one for heavy loads at low speed, and one for light loads at high speed. Usually these hoists are both on the same trolley, but occasionally the crane is built with two trolleys, one for each hoist.

Some of the reasons for the high efficiency of the overhead crane are: first, that it operates high above the working level and so interferes a minimum amount with the freest possible use of the floor space; second, it gives equal service to all parts of the shop; third, it is equally handy on all levels up to its own height; fourth, as a traveler it can make speeds that would be impracticable on the floor level; fifth, in size and capacity it can be varied to meet any and all requirements; and sixth, although it is the most flexible of all handling contrivances, it is the most easily controlled.

Unlike many machines it is not necessary to use a crane constantly to make it a paying investment. Particularly this is the case where the loads to be moved are heavy. In many shops where heavy work is done the crane may be used only three or four times in a day, but the labor saved in those few operations may and usually does more than pay the expense of the crane. In power

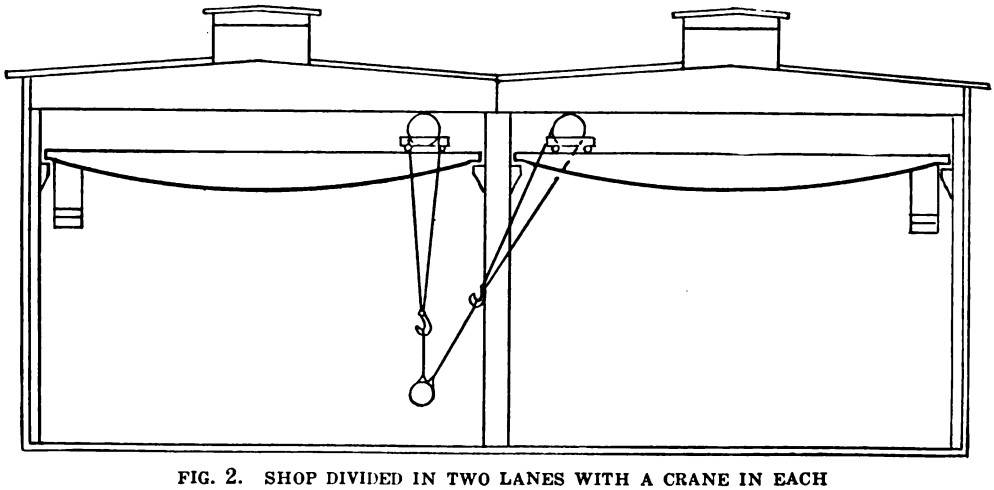

FIG. 2. SHOP DIVIDED IN TWO LANES WITH A CRANE IN EACH

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houses cranes are almost universally installed, and are used only on repair work, but when the emergency arises

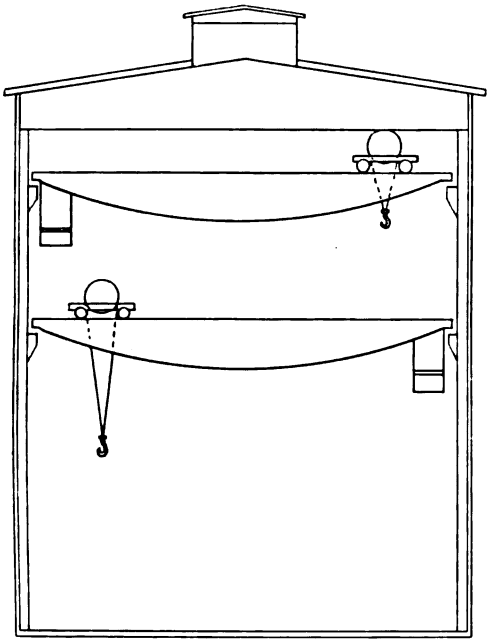

FIG. 3. SHOP WITH TWO CRANES, ONE ABOVE THE OTHER

the crane is ready to do the work in a short time, paying for itself very quickly in some cases where long waits would be expensive. Think of the time saved when a casing must be removed from a large steam turbine, or when a roll breaks in a steel mill where the loss while the mill is idle runs into the hundreds of dollars each hour!

On the other hand, if the objects are small and cannot be grouped together, crane handling may prove to be the most expensive way. Even a small power crane may cost not less than fifty cents an hour to operate, exclusive of the operators wages. In many cases where light objects are to be moved figures will show that the moving may be done by hand trucks cheaper than by a crane. In case of a large crane it may even cost more to bring the crane in position to pick up a small article than to carry the article the required distance by hand. If the articles moved are to be stacked up, then the crane is usually the cheaper method. The writer recently visited a storage warehouse where boxes of machinery weighing from 100 to 400 pounds are stored until the consignments are completed. Floor space in this building is valuable, so the boxes are stacked. To facilitate this work the building is divided longitudinally into three lanes, and in each lane there is an overhead electric traveling crane of one-ton capacity. These cranes were installed after several other methods of handling were tried.

The mere size and weight of the objects to be handled by no means defines the sphere of usefulness of the

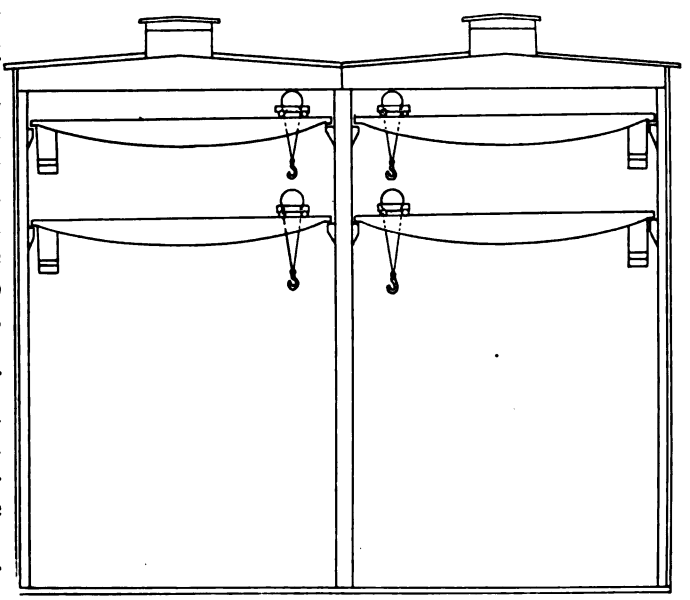

FIG. 4. SHOP DIVIDED INTO TWO LANES WITH TWO CRANE TRACKS IN EACH, ONE ABOVE THE OTHER

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crane. By grouping articles, parcels of a size and weight to make it pay to use cranes may often be formed. In order to do this it may be necessary to arrange the routing of the material through the shop in such a way that at certain points the individual articles may collect long enough to form a reasonable load for the crane to handle.

The arrangement of cranes in a shop depends entirely on the character of work to be done. The simplest arrangement is to have one crane with a span long enough to include the full width of the shop. This arrangement, Figure 1, is inexpensive and should be used only where delays while waiting for the crane are not costly. Even if this arrangement is installed originally other cranes may be put on the same tracks as the increase in work may demand them. It is not unusual to find three or four cranes operating on the same track in busy foundries, machine shops, or steel mills. Under such conditions each crane serves a certain portion of the shop and there is no chance of interference.

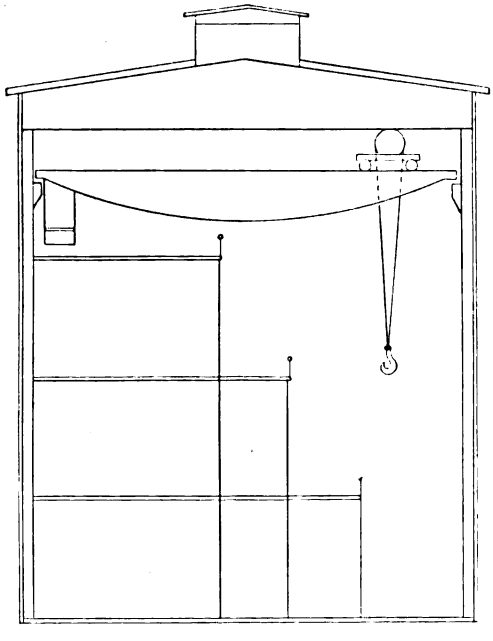

FIG. 5. ONE CRANE SERVING SEVERAL FLOORS IN A SHOP

When it is desirable to have a crane serve the full length of the shop and still have two or more cranes to do the work, the building may be divided up into lanes, with a crane for each. This arrangement is shown in Figure 2, which also illustrates a method of passing a load from one crane to another across the shop.

In some shops it is necessary to provide more cranes than can be accommodated on one track. In that case two tracks are used, one above the other (Figure 3), and there may be also several cranes on each. A step further is to use the "lane" division with two tracks in each lane. One of the large machine shops of the General Electric Company at Schenectady is divided into two of these longitudinal lanes or divisions, in each of which there are two tracks, one above the other; and on each track there are three cranes of different capacities, the largest being capable of lifting one hundred tons. This arrangement is illustrated in Figure 4.

There is a certain type of machine shop in which heavy work is done in one portion of the building, one story high, while light work is done in a parallel section several stories high. The light work is usually handled by means of trucks, and when the parts manufactured are small, many of these parts are collected to form a truck load. In the course of manufacture these light parts may pass from one floor to another. This phase of the handling may be done by the crane over the one-story part of the building as indicated in Figure 5. In this instance, each floor above the ground projects out a little further than the one above. A modification

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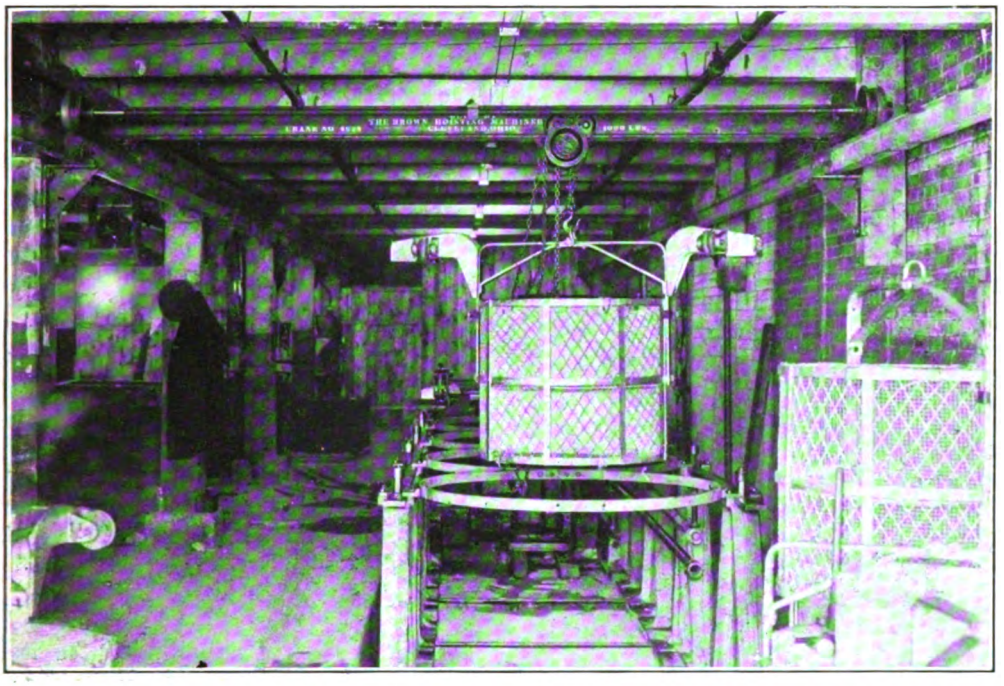

FIG. 6. BROWNHOIST ½-TON HAND OPERATED CRANE IN THE PLANT OF THE CONEY AND JOHNSON COMPANY, CLEVELAND, OHIO

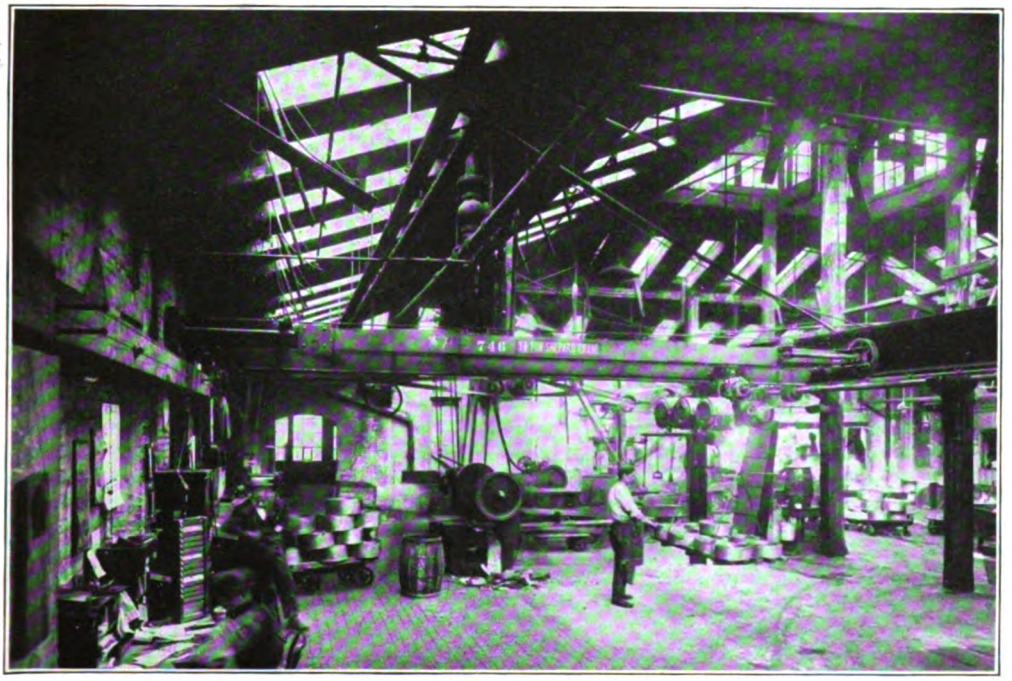

FIG. 7. SHEPARD 1½-TON ELECTRIC CRANE OPERATED FROM THE FLOOR BY PENDANT CORDS

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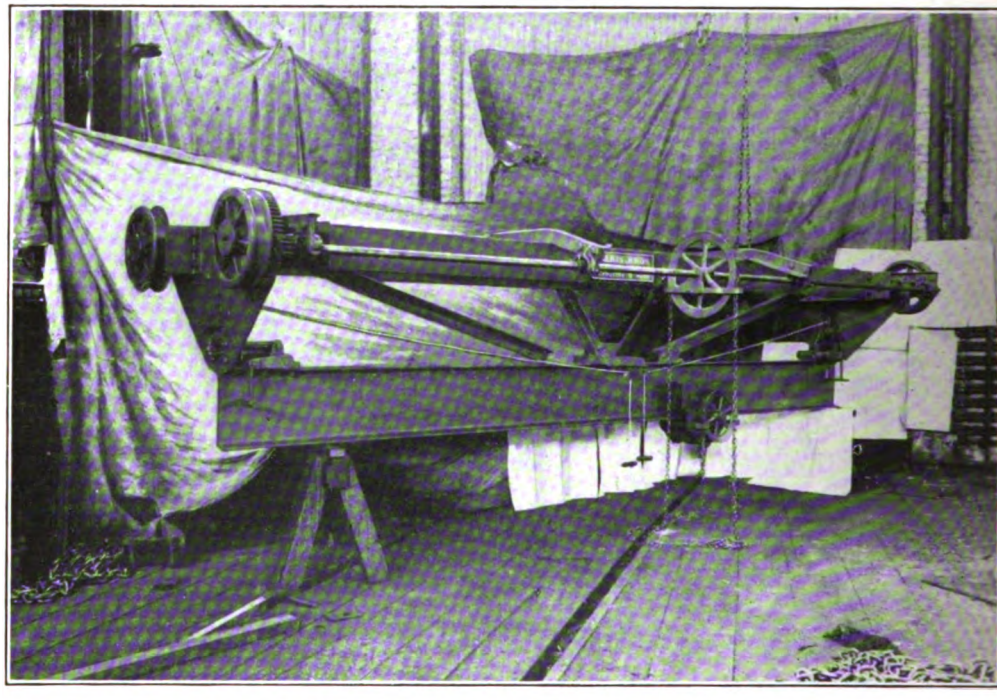

FIG. 7A. MARIS BROTHERS 5-TON HAND OPERATED CRANE WITH CHAIN HOIST TROLLEY USED ALSO AS A TRANSFER CRANE

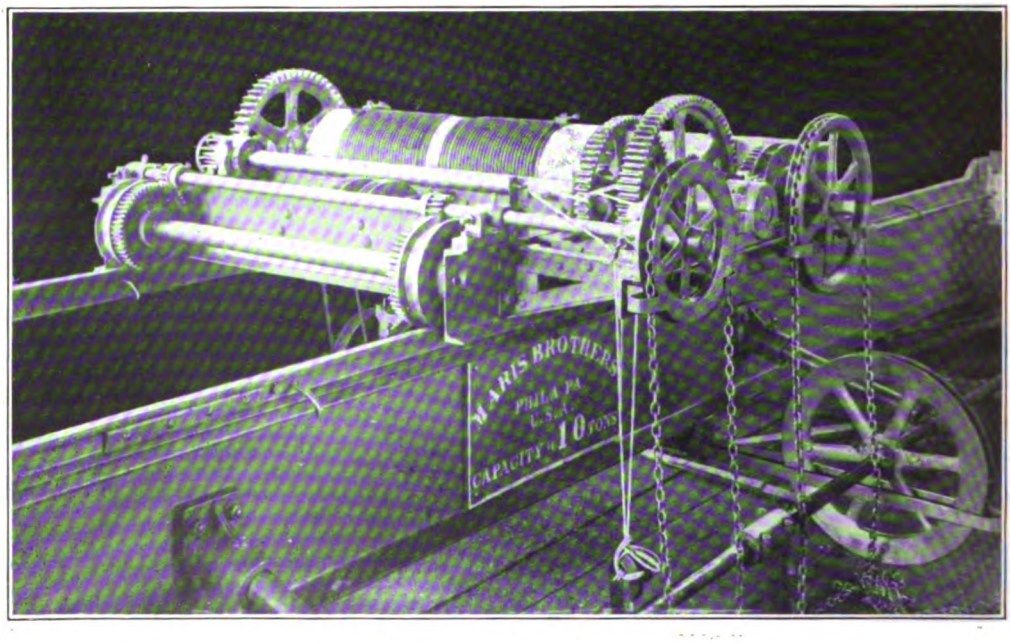

FIG. 7B. MARIS BROTHERS 10-TON HAND OPERATED CRANE WITH TROLLEY ARRANGED FOR TWO HOISTING SPEEDS

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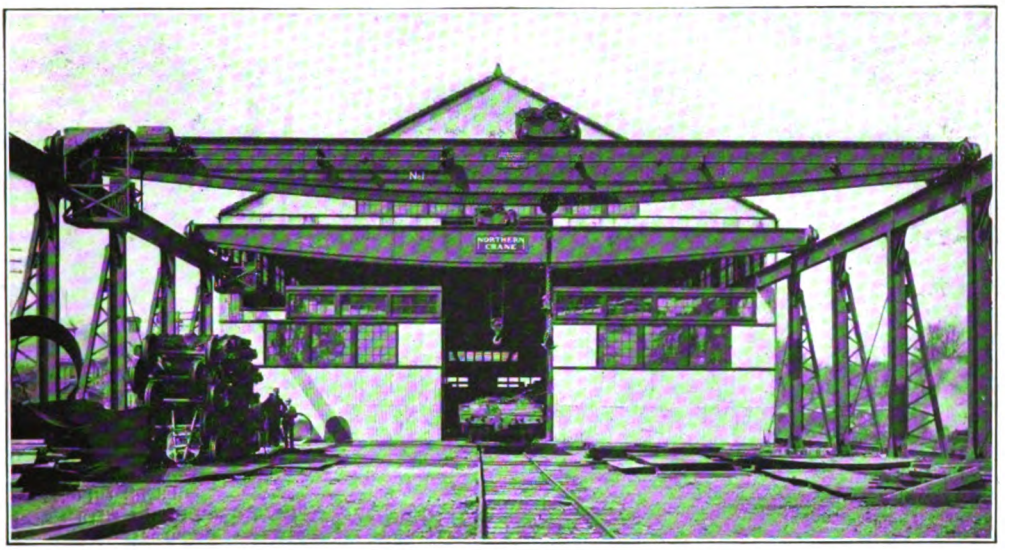

FIG. 8. NORTHERN OVERHEAD ELECTRIC CRANES FOR SHOP PURPOSES AND STORAGE YARD

of this arrangement is to have a landing stage built out from each floor, with the precaution that a stage on one floor shall not be directly over the stage on the floor below.

In selecting overhead cranes the user should consider other things than the mechanical construction, speed, etc. One important consideration should be the amount of material to be handled in loads that will fall below the capacity of the crane. In selecting cranes for a new shop it is sometimes difficult to determine before the shop is in operation just how many cranes will be needed.

There is one point, however, that makes the selection of cranes flexible; if one crane is found to be insufficient for the work another can be added. To determine the question of whether to install an additional crane is not always easy. No man could walk into a machine shop, look around casually, and decide the question offhand. Instead, time studies should be made to determine the amount of time lost by the various machines while waiting for the crane. The value of the total time lost should be more than enough to pay the fixed charges and operating expenses of the additional crane.

If heavy work is to be handled occasionally, the crane should be of sufficient capacity to take care of this work. If two cranes are to be installed, then smaller ones may be used. A machine shop might have occasion to handle a 25-ton base plate once or twice a day, all the other pieces being below 15 tons. If two cranes could be utilized to advantage, the capacity of each need not be more than 15 tons, as the two together can care for the heavier work.

Too much stress cannot be laid on the fact that every moment a machine is idle represents a dead loss to its owners, whether it be idle from lack of material, breakdown, or lack of crane service. Anything that can be done to cut down the idle machine time, therefore, is of value, providing that the cost of cutting down the idle time is not greater than the value of the time saved.

CONSTRUCTION OF OVERHEAD CRANES

All overhead cranes should be constructed in accordance with safety-first principles. The workmen in the

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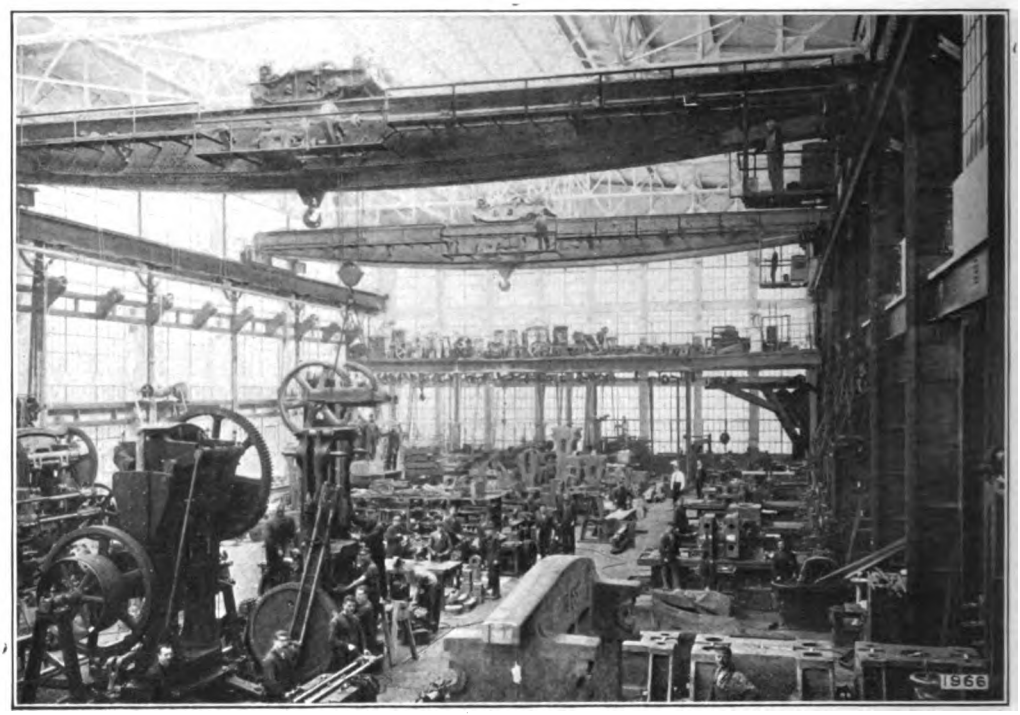

FIG. 9. TWO SHAW OVERHEAD ELECTRIC CRANES IN THE MACHINE SHOP OF E. W. BLISS & CO.

shop should feel that they are perfectly safe with the crane passing back and forth over them with loads of any kind. If this freedom from anxiety is not present, enough time will be lost by the workmen dodging the crane load to offset the time saved by the crane. It goes without saying that the bridge of the crane and all the parts that carry the load directly should be designed with a generous factor of safety. This factor should be large, not alone because the crane carries its loads over the heads of the workmen, but also because the crane is subjected to rough usage, and the stresses brought upon it are frequently larger than those due simply to dead loads. These stresses are due to jerking actions of the load, stopping and starting quickly under load, and using the crane for work for which it was not designed.

A complete set of reliable brakes should be used in order to hold the load safely at any point after it is raised. As far as possible mechanical brakes should be enclosed and should run in oil or grease. In addition to the mechanical brake every crane should have a solenoid brake which instantly checks the armature of the hoisting motor and prevents drifting of the hook. Bridges should have a foot brake. In many cases where direct current is used the dynamic brake has been found beneficial; such a brake will take the place of the mechanical brake, but in all cases the electric solenoid brake should be used as a supplementary brake. The wiring of the motors should be carefully done, the wires running in steel conduits wherever possible. Wherever there is headroom enough a footwalk should be provided with a strong hand-rail the whole length of the bridge.

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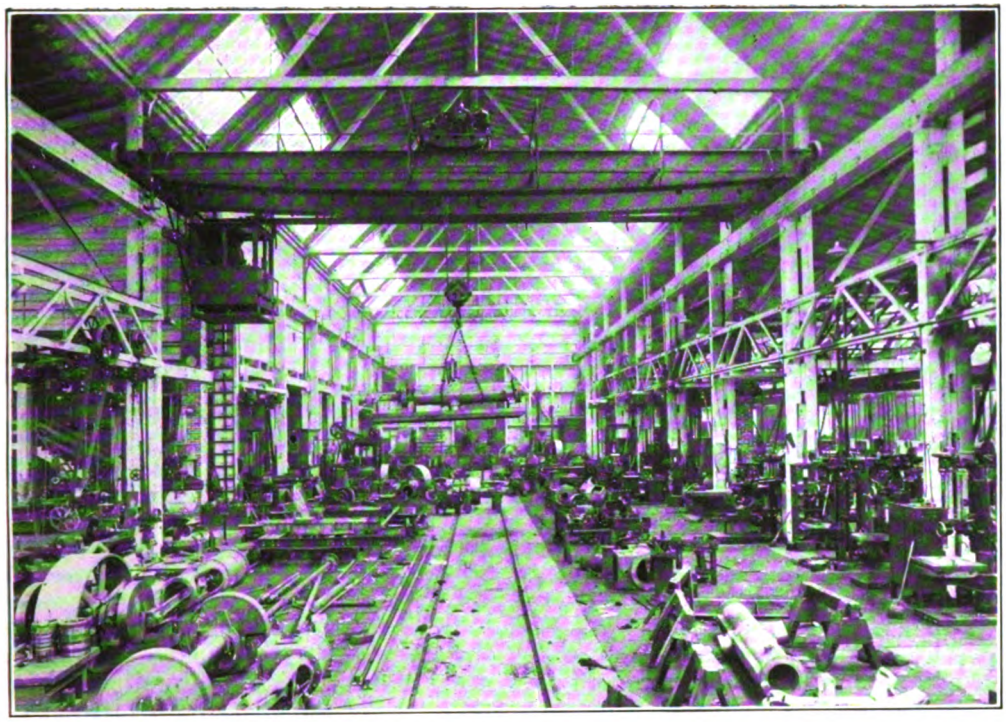

FIG. 10. PAWLING AND HARNISCHFEGER 10-TON ELECTRIC CRANE SERVING MIDDLE BAY OF MACHINE SHOP MANUFACTURING STEAM ENGINES

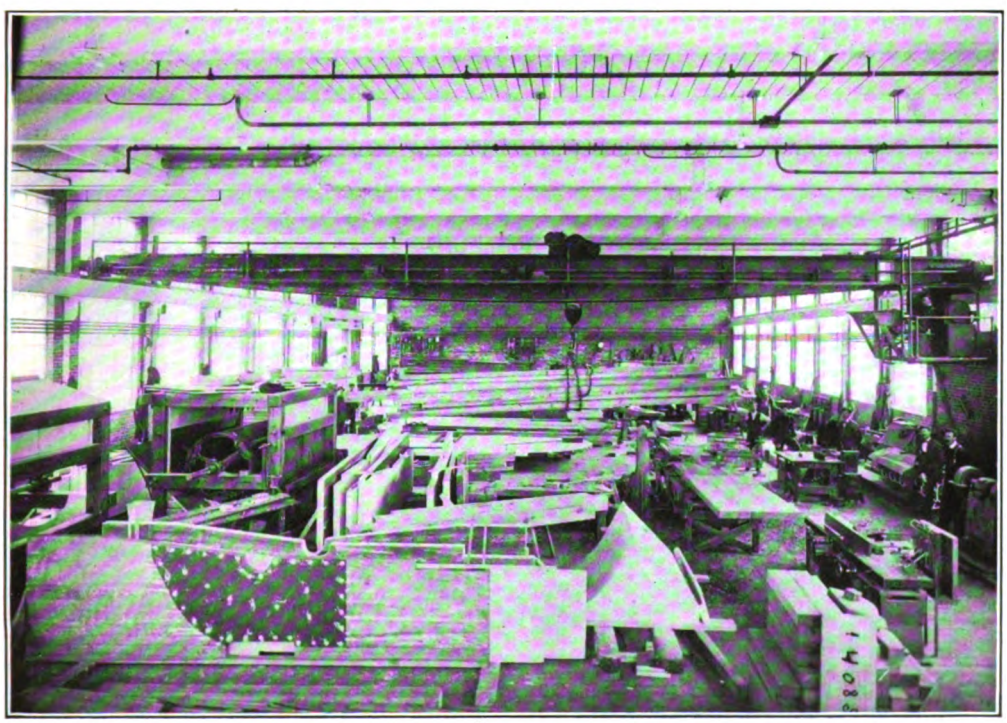

FIG. 11. SHEPARD 5-TON CRANE OF LONG SPAN HANDLING LUMBER IN A PATTERN SHOP

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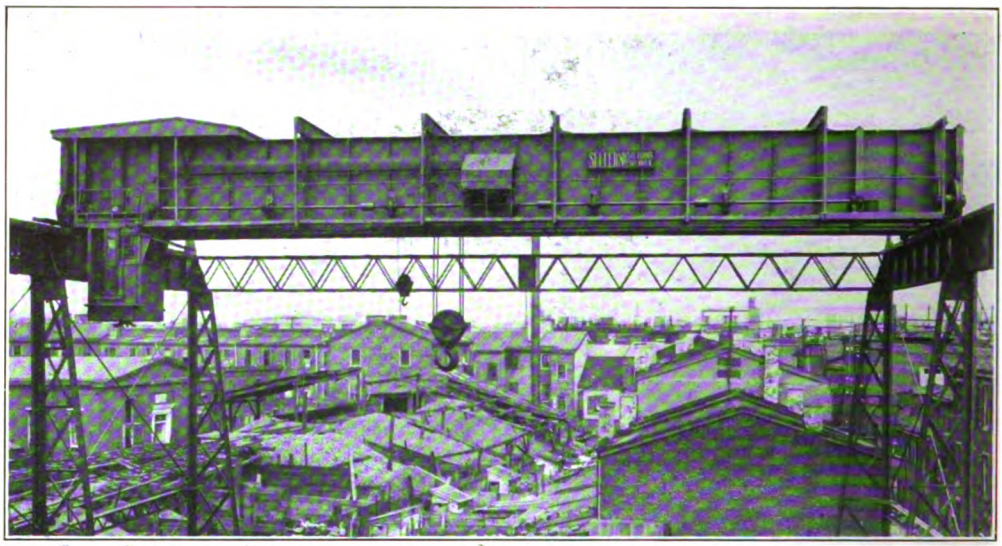

FIG. 12. SELLERS 50-TON OVERHEAD CRANE WITH A 5-TON AUXILIARY HOIST
Plant of the Southwark Foundry and Machine Co., Philadelphia. The span of the crane is 69 feet, 4 inches, lift 42 feet.

A general outline of the most recent practice in overhead crane construction is interesting and will be given here. The bridge may be and is made in various ways, the simplest form being the single plain I-beam used in light cranes which are usually hand operated. One of the most important features of the crane bridge is stiffness, both in the vertical and in the horizontal direction. The stiffness in the vertical direction is to take care of the load, that in the horizontal direction to take care of the strains due to sudden stopping and starting and pulling on loads at an angle. The loads brought on the bridge in the vertical direction are

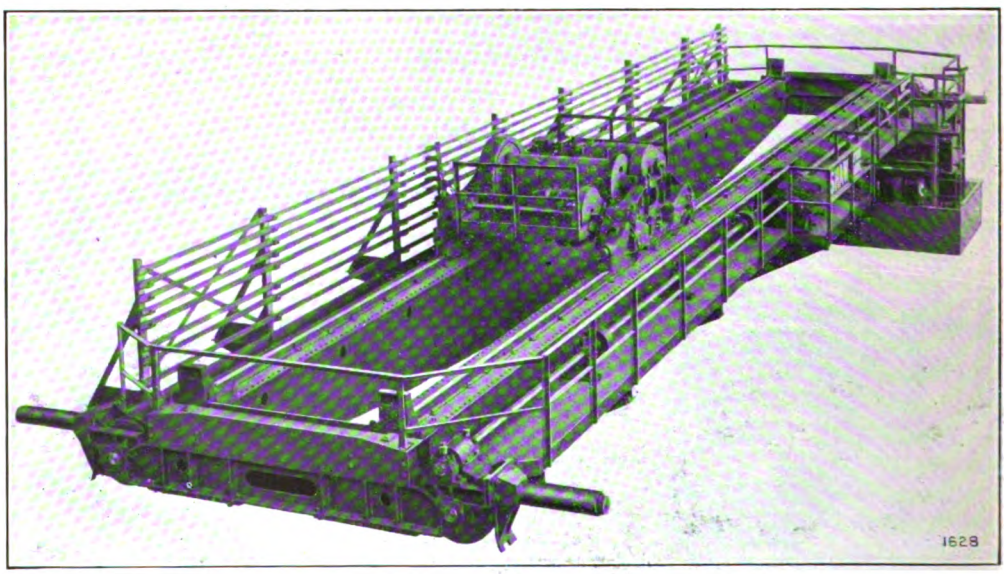

FIG. 13. SHAW ELECTRIC OVERHEAD TRAVELING CRANE WITH BOX GIRDERS

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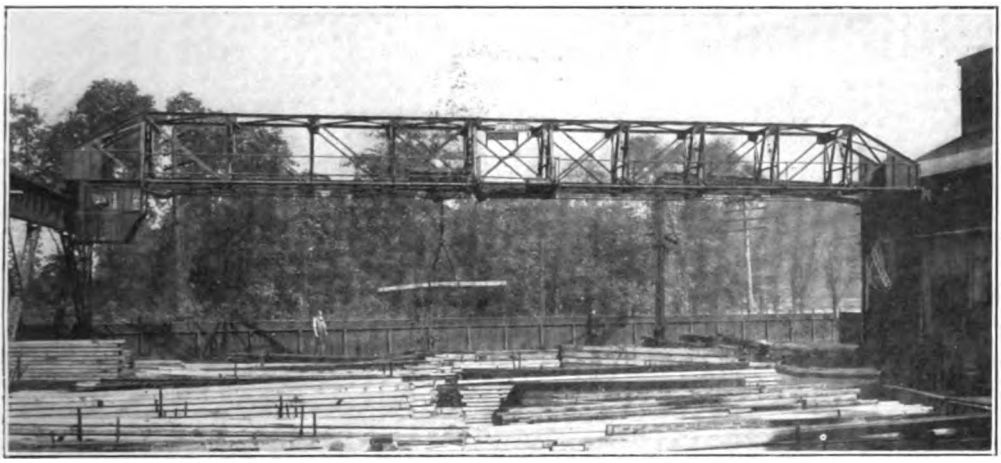

FIG. 14. BROWNHOIST OVERHEAD CRANE WITH BRIDGE BUILT UP OF LIGHT SECTIONS

easily determined, those in the horizontal are not. For these reasons the single I-beam or the single girder of any kind should be used only on small cranes and preferably on those in which the bridge is moved by hand. Light, simple I-beam cranes are shown in Figures 6, 7, and 7a. The first is a ½-ton Brownhoist crane, with a Yale triplex hoist mounted on a hand trolley which runs on the lower flange of the I-beam. The second shows a Shepard 1½-ton electric crane with floor-controlled motors for the hoist, trolley transverse, and bridge.

Figure 7a shows a Maris Brothers single I-beam hand-operated crane used also as a transfer. Each end of the crane is provided with automatic stops and locks to prevent the load being pushed off while the transfer is at an open position, and also for locking the crane directly in alignment with permanently located sections of the runway beam corresponding to the beam of the crane. With a crane of this sort in the center bay of the building, the hoist can be placed over a machine in any part of a side bay, where there would be no room for a crane bridge to move up and down on account of interference of belts, etc.

The next higher type of bridge is the one made of two I-beams placed side by side and connected at the ends by means of steel castings or structural shapes. The double-bridge scheme is used on practically all electric cranes, as it is much stiffer than a single bridge girder and is much more convenient for carrying the trolley and the bridge wheels. For all cranes heavier than about five tons the bridge girders are built up of

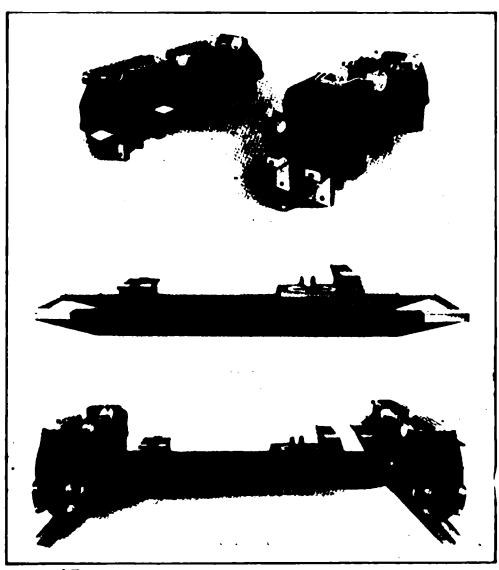

FIG. 15. CASTINGS WHICH GO TO MAKE UP THE TROLLEY FRAME OF A MORGAN CRANE

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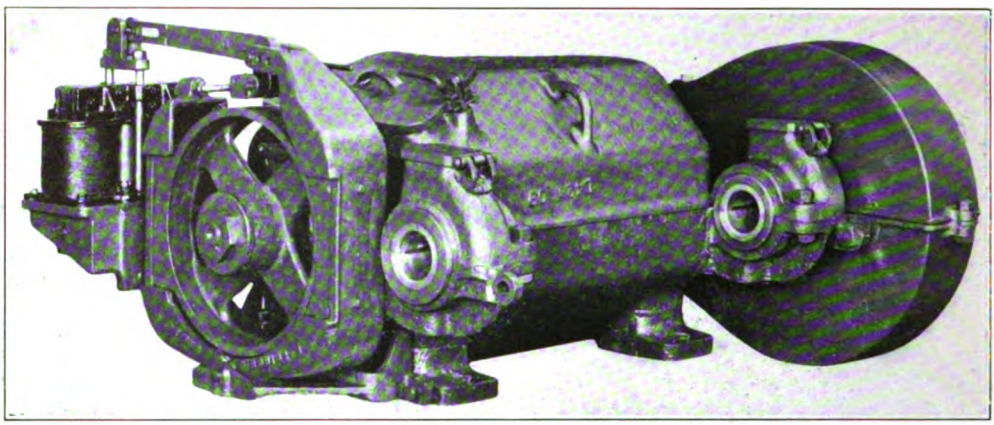

FIG. 16. GENERAL-ELECTRIC INDUCTION CRANE MOTOR WITH SOLENOID BRAKE

plates and angles. When the span is very short heavy rolled sections may be used.

This type is illustrated in Figure 7b which shows a Maris Brothers 10-ton crane with hand-operated bridge, trolley, and hoist. The hoist has a double set of hoisting gears, either set being worked by pulling on the cords shown in the illustration, and operating the clutch engaging for slow or fast speed. This crane, except in speed of operation, is intended to serve every purpose that an electric crane of like capacity can.

For long spans the girder is usually made approximately of uniform strength, that is, deep at the center where the bending stresses are a maximum, becoming shallower at the ends, as shown in Figures 8, 9, 10, and 11. This construction is not always used in heavy capacity cranes as indicated by Figure 12, which shows a Sellers crane of 50-tons capacity having a span of 69 feet 4 inches. This particular crane is of a type called the through-bridge, and is somewhat different from the deck-bridge type. The difference is that in the through-bridge crane the trolley runs between the bridge girders on rails carried on the lower flanges, while in the deck-bridge type the trolley runs on rails carried on the tops of the girders. The former type al-

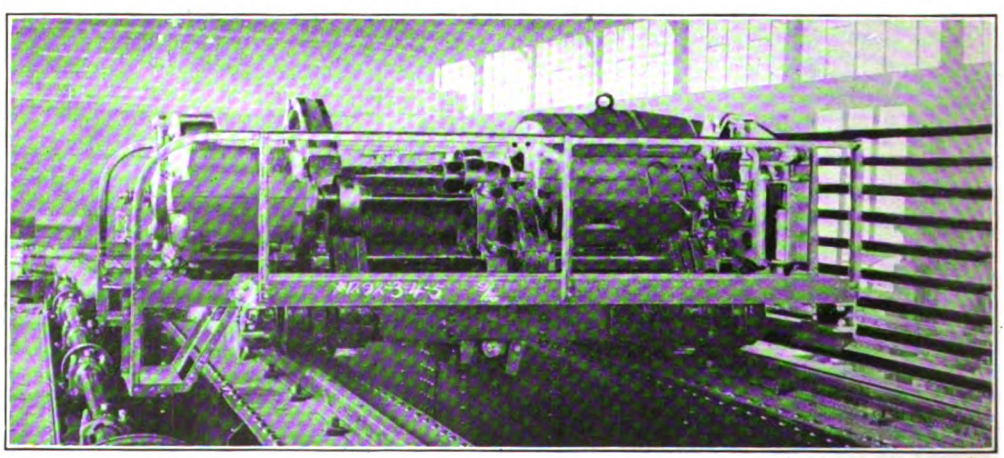

FIG. 17. CROCKER-WHEELER 50-HORSEPOWER MOTOR ON BRIDGE OF CASE CRANE

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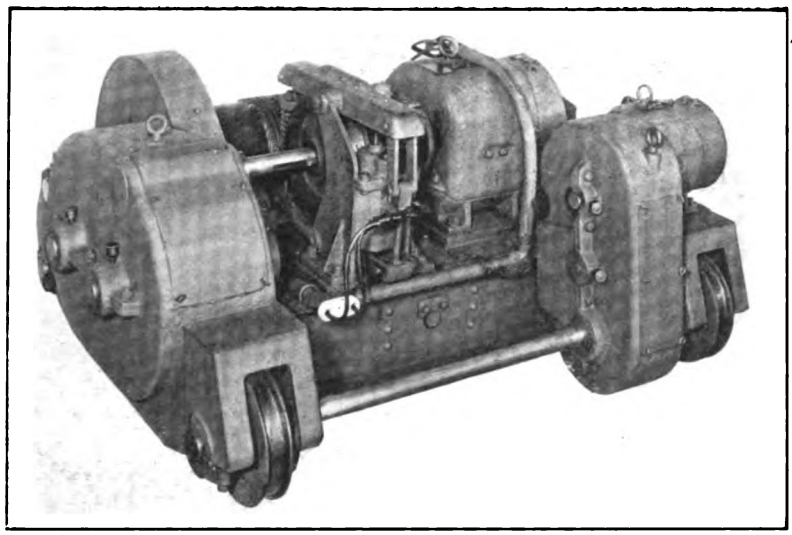

FIG. 18. NORTHERN 10-TON TROLLEY WITH TWO MOTORS

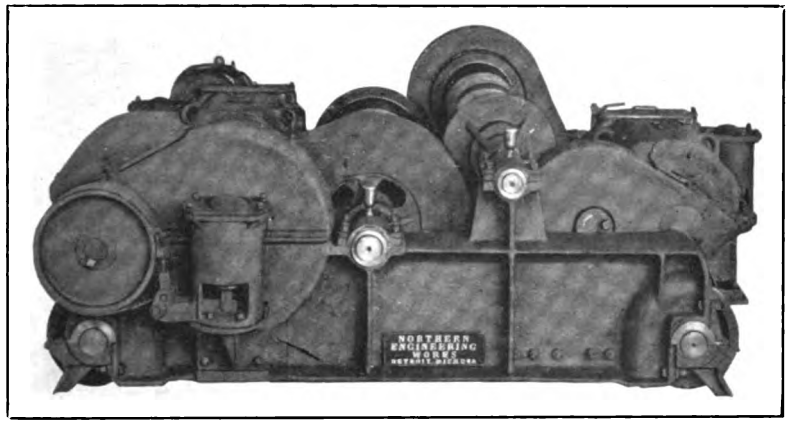

FIG. 19. NORTHERN 40-TON TROLLEY WITH 10-TON AUXILIARY HOIST. TROLLEY IS OF CAST STEEL CONSTRUCTION

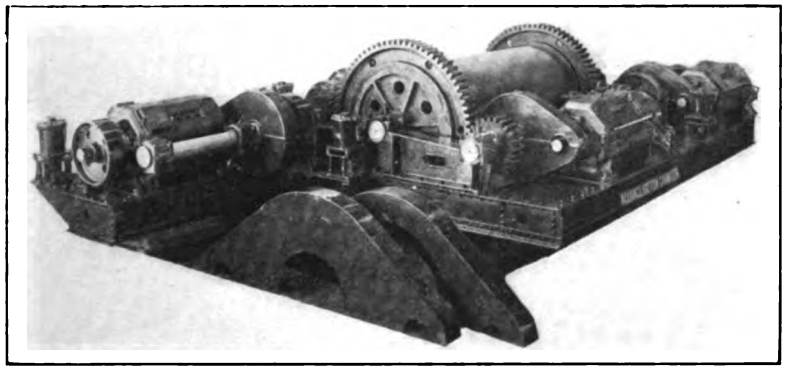

FIG. 20. ALLIANCE 100-TON TROLLEY WITH FOUR MOTORS ON MAIN HOIST

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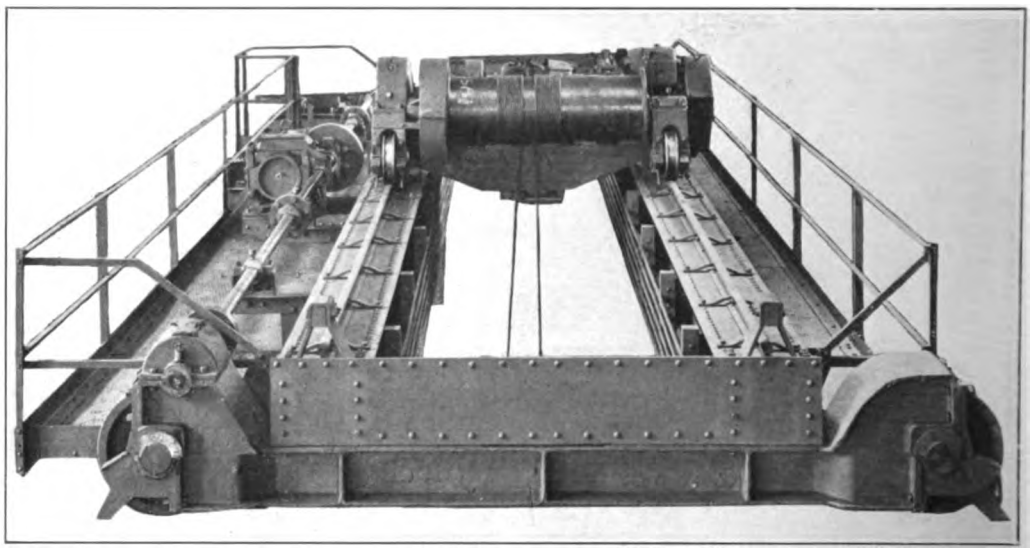

FIG. 21. NORTHERN 10-TON CRANE WITH ONE HOIST

lows lateral diagonal bracing between the tops of the girders, which increases the lateral stiffness of the bridge very materially.

As a rule, crane bridges are built up with a single plate web, but in some cases a box girder is used on very heavy cranes. This type is illustrated in Figure 13 which shows a Shaw crane for heavy mill service. In certain cases, bridges for light cranes and long spans may be built up of angles, as seen in Figure 14 showing a Brownhoist electric crane used for

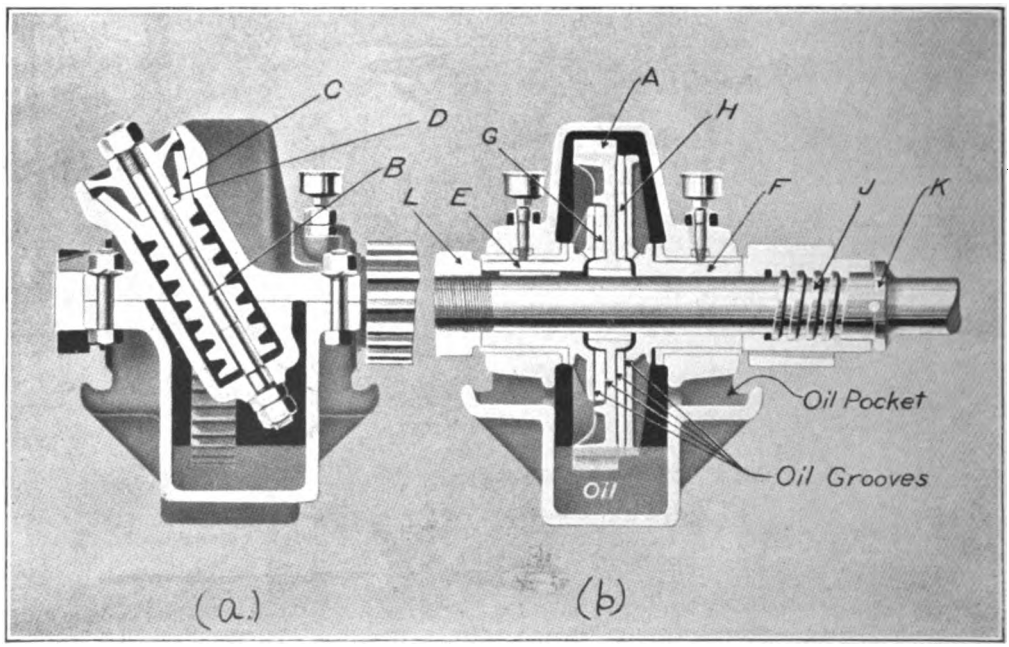

FIG. 22. MECHANICAL LOAD BRAKE USED ON MORGAN CRANES

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handling steel in a storage yard. Such a construction gives a stiff bridge of great length but without undue weight.

The trolley of the overhead crane is the part which traverses the bridge from end to end. The frame of which the trolley is composed carries the hoisting drums, motors, gears, brakes, etc. Because it has so many different parts to carry, and because of the necessity for keeping all the parts in a small space, the frame is usually of a very complicated form. Structural shapes do not lend themselves readily for this work, hence steel castings are more generally used. One large company, however, which has experimented with both the cast and the built-up types of trolley decided to use a trolley made up of rolled shapes.

The trolley frame proper is divided into at least three parts: two sides, and a connecting piece called the girt. The girt is a closing member or distance piece, and forms a completed frame with the sides. These pieces, as made by the Morgan Engineering Company of Alliance, Ohio, are shown separated and assembled in Figure 15. In this case the girt and the side frames carry the drums, gears, motors, and brakes, but the upper sheave is carried on a lifting beam which is suspended directly over the bridge rails from pins placed through lugs cast on the trolley frames. In some cranes the upper sheave is fastened directly to the girt. In still others, such as the Shaw crane of large capacity, there are two cast "machinery girts" which carry the motors, etc., while a third "load girt" of structural steel is put in place between the machinery girts.

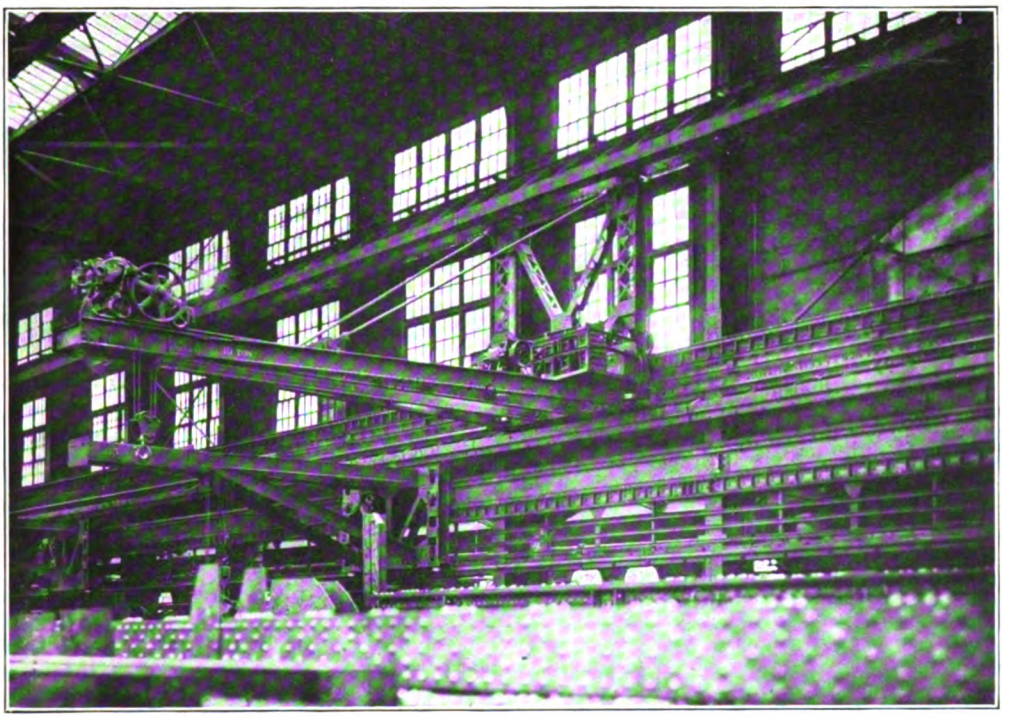

FIG. 23. ALLIANCE 10-TON TRAVELING WALL CRANE IN SHOP OF MESTA MACHINE CO.

The motors of an overhead crane may be either of the direct or alternating current type and are usually operated on current supplied at 220 volts. Not many years ago it was

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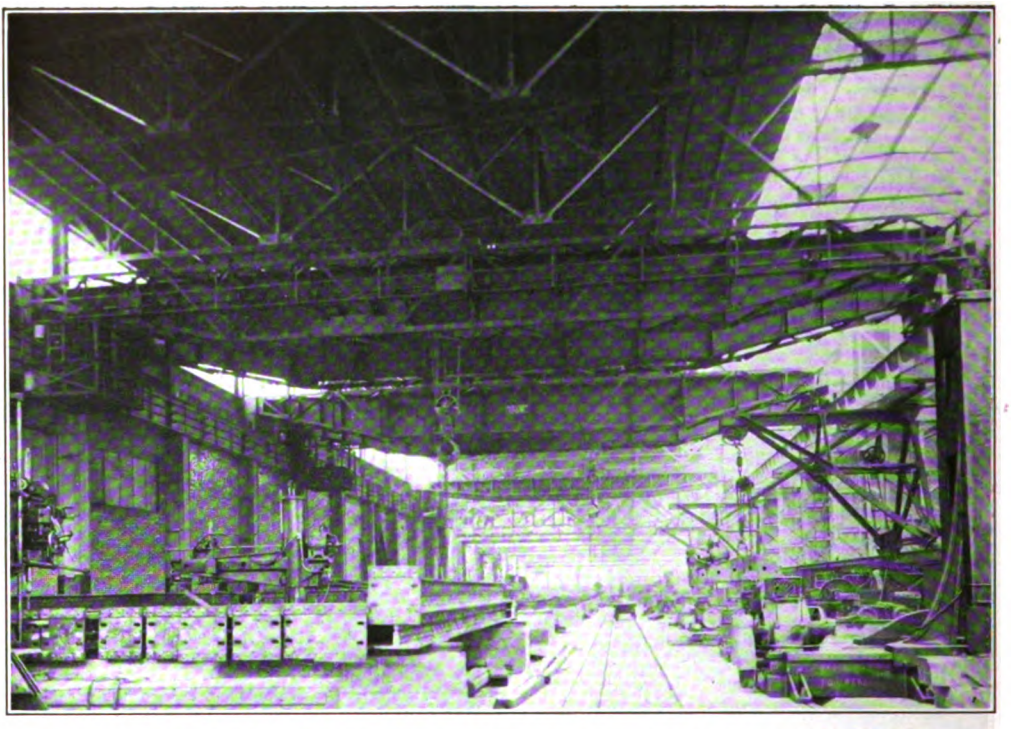

FIG. 24. NORTHERN WALL CRANES USED IN CONJUNCTION WITH OVERHEAD CRANES

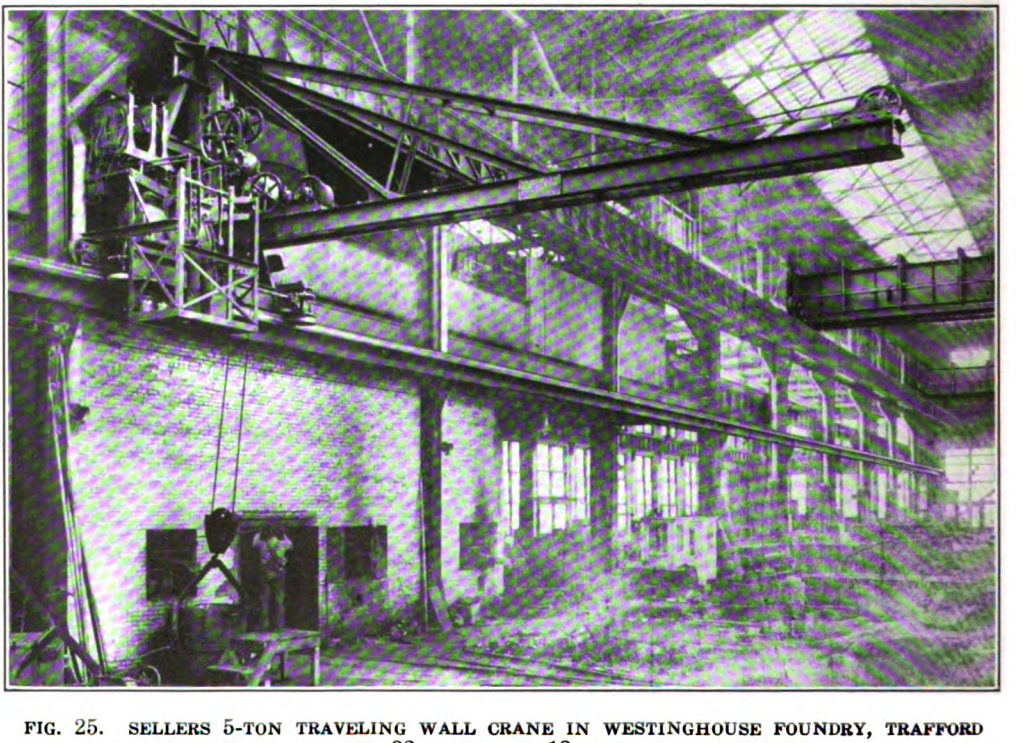

FIG. 25. SELLERS 5-TON TRAVELING WALL CRANE IN WESTINGHOUSE FOUNDRY, TRAFFORD CITY, PA. RADIUS 32 FEET, LIFT 18 FEET. THREE MOTORS

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FIG. 26. SHAW WALL CRANE AT THE PLANT OF TAYLOR, WHARTON IRON AND STEEL CO., HIGH BRIDGE, N. J. CAPACITY 5 TONS, REACH 20 FEET

thought necessary to use series-wound direct-current motors, but since the development of induction motors which will start under load, alternating current is widely used. A General Electric induction motor with a solenoid brake for crane service is illustrated in Figure 16. The enclosed motor is a big asset for crane service, as it will not be affected by dirt and withstands the rough usage to which every crane is subjected better than an open type of motor.

Crane motors, particularly those used for hoisting, should be so wound as to accommodate automatically their speed to the loads handled, in order that the light and medium loads may be moved at relatively high speeds and the maximum loads at low speeds. All direct-current motors have these characteristics to some extent, but it has usually been impossible to secure all the automatic speed variation which is desirable without serious commutator and brush troubles. By use of interpole motors, however, a nearly uniform rate of drop of the saturation curve between maximum and minimum load is possible with a corresponding uniform speed variation and perfectly sparkless commutaton.

The motor used for propelling the bridge is an enclosed reversible motor very similar to the hoist motor, but it is not necessary for it to have the characteristics for small and heavy loads mentioned above because its load is nearly uniform in all cases. A bridge motor of 50 horsepower made by the Crocker-Wheeler Company, Ampere, N. J., and installed on a case crane is shown in Figure 17. The brake shown is not of the solenoid type but is operated by a hand or foot lever in the cab. The solenoid brake would not be applicable to this motor as it would not allow "drifting" of the bridge.

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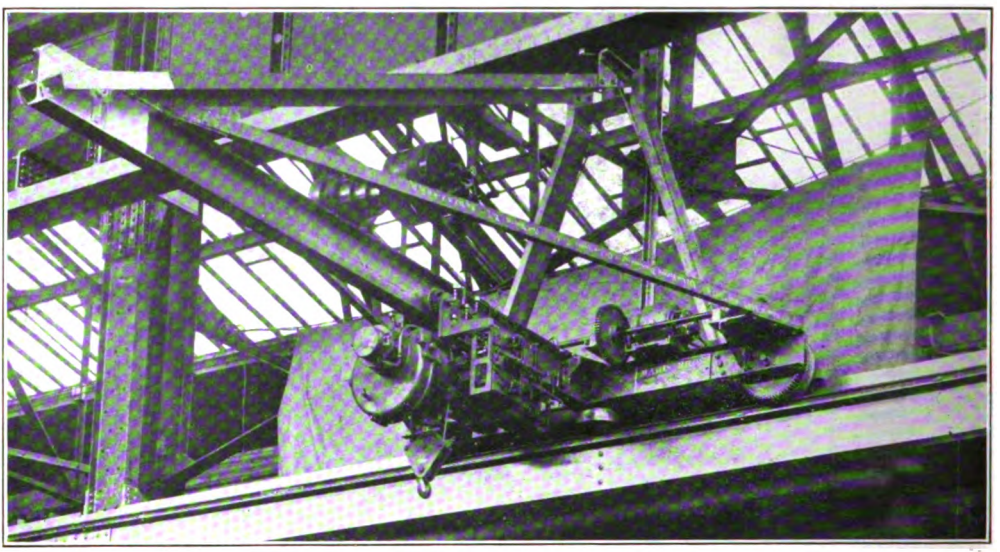

FIG. 27. MARIS BROTHERS 2-TON WALL CRANE WITH ELECTRIC HOIST ON I-BEAM

The number of motors used on overhead cranes depends on the number of hoists and trolleys, and on the capacity of the crane. The number used with a single-hoist crane of medium capacity is three, one for the bridge travel, one for the trolley traverse, and one for the hoist. If an auxiliary hoist is located on the same trolley as the main hoist, their drums being placed parallel to and near the edge of the bridge so that the cables will fall outside the bridge and not interfere with the operation of the auxiliary trolley running on the lower inside flanges of the bridge, seven motors will be used.

The arrangement of a 10-ton Northern trolley with two direct-current motors, one for the hoist and one for traversing the trolley, is illustrated in Figure 18. The solenoid brake on the hoisting motor is plainly shown in the center of the figure. A 40-ton Northern trolley with a 10-ton auxiliary hoist is shown in Figure 19. The auxiliary hoist motor is the one at the right, the main hoist motor is the one at the left in the foreground. The traversing motor is barely visible in the background at the left. In Figure 20 is shown an interesting trolley of a 100-ton Alliance crane with four motors geared to the main hoist drum, in pairs at either end.

The reduction gears used between the motors and the work on cranes should be made of hard close-grained steel or semi-steel and should have cut teeth large enough to work with low stresses. Pinions are usually forged from steel high in carbon and manganese. Some makers cut the teeth in the 20-degree involute form to secure additional strength. All crane gears should be enclosed, not only for the good of the gears, but also for the sake of safety. Whenever it is possible the gears should run in oil, but where this is not possible sufficient lubrication in some form should be provided.

One of the most important parts of the overhead crane is the brake system. Brakes are provided on the bridge, on the hoist, and sometimes on the trolley. The bridge brake is usually of the band type; it is located on the bridge-motor armature shaft and is operated by a foot lever in the

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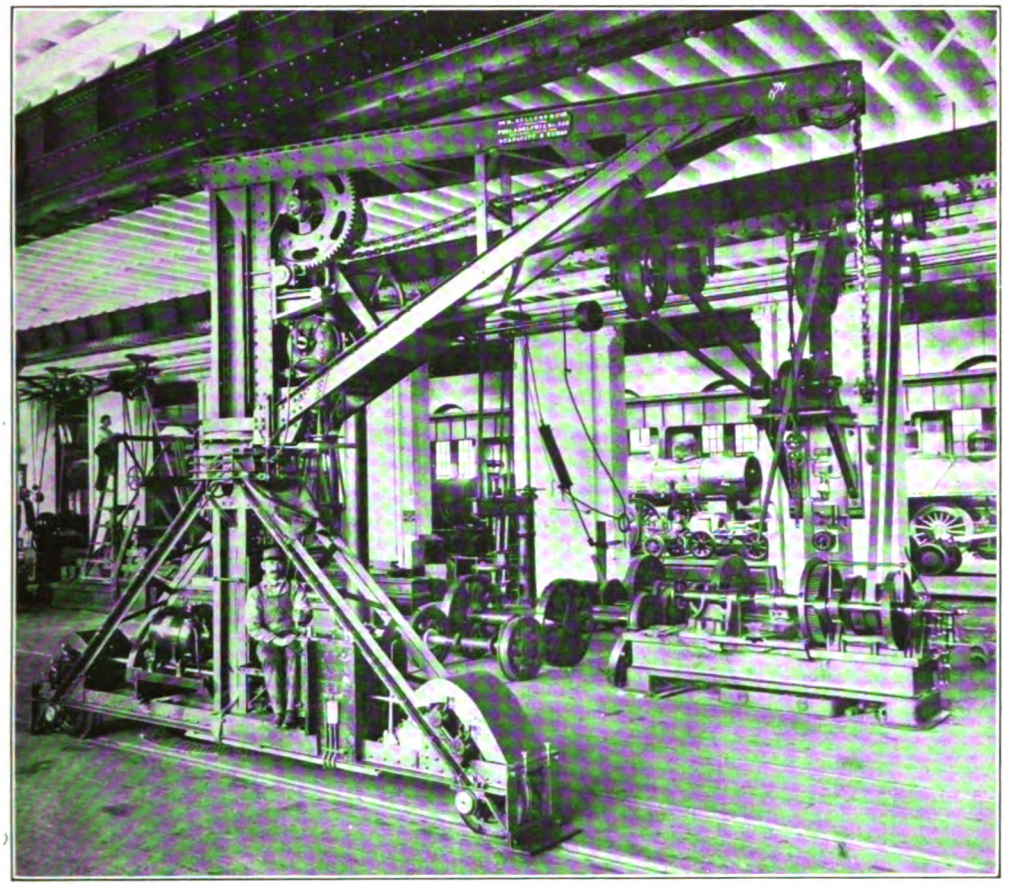

FIG. 28. SELLERS WALKING JIB CRANE IN MT. CLARE SHOPS OF BALTIMORE AND OHIO RAILROAD. RADIUS 15 FEET, 6 INCHES; LIFT 16 FEET, 3 INCHES; CAPACITY 5 TONS

cab. The trolley brake, when used, is of a similar type; in many cases this brake is omitted and the braking is done entirely by reversing the motor. The two types above mentioned may be utilized in operating the bridge and trolley at high speeds. If it were necessary to allow the bridge and trolley to come to rest simply by friction, operating speeds would have to be low indeed.

The most important brakes used on cranes are those used for safety purposes, the load brakes, which hold the load after it is hoisted or prevent its rapid drop when lowered. There are two types of brakes designed to hold the load automatically in any position; these are the solenoid brake and the mechanical brake. The solenoid type is a band brake on the motor shaft and is held in the engaged position by a spring or weight. A solenoid coil in the power circuit to the hoist motor is arranged so that when the current is turned on the motor to raise or lower the load, the core of the solenoid lifts the weight, if the brake be of the weight type, or compresses the spring, in case a spring is used, and releases the brake. The instant the current is turned off, the weight or spring causes the brake band to grip the band wheel with sufficient force to hold the load. This type is illustrated in Figures 16, 18, 19, and 20.

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Mechanical load brakes are usually made up of discs which revolve together when the load is being raised. These discs may be located on the hoist-motor shaft or on a separate geared shaft. When the load is raised and the current turned off, the pull of the load through a ratchet forces the discs together, usually by means of a screw thread, and the load is held by friction, since one disc is prevented from turning by the ratchet pawl. In order to lower the load, the motor must overcome the friction which is dissipated as heat.

A load brake working on a principle different from that just described is that built by the Morgan Engineering Company, Cleveland, Ohio, illustrated in Figure 22. The friction discs *G* and *H* are keyed to the shaft and revolve with it. The disc, *A*, has ordinary gear teeth cut in its outer periphery which mesh with the worm shown at (*a*). The angle at which the worm is placed allows the disc *A* to slip along the shaft owing to the wear of the friction discs *G* and *H*. The worm revolves freely on its shaft *B* and has a slight endwise movement which is adjustable and in practice may be as low as one-hundredth of an inch. In lowering, the load on the brake is in a direction such as to force the worm downward, so that the cone *C* at the top of the worm engages with a corresponding taper machined in the casting and by friction prevents the worm being driven by gear *A*. In hoisting, the gear *A* lifts the worm free from this frictional contact and forces it up against the fibre washer *D* which is nearly frictionless; and, consequently, both the worm and the disc *A* are free to revolve. In lowering, with *A* held from revolving by the worm, and *G* and *H* forced against *A* by the thread *J*, the friction is enough to hold the load and must be overcome by the motor.

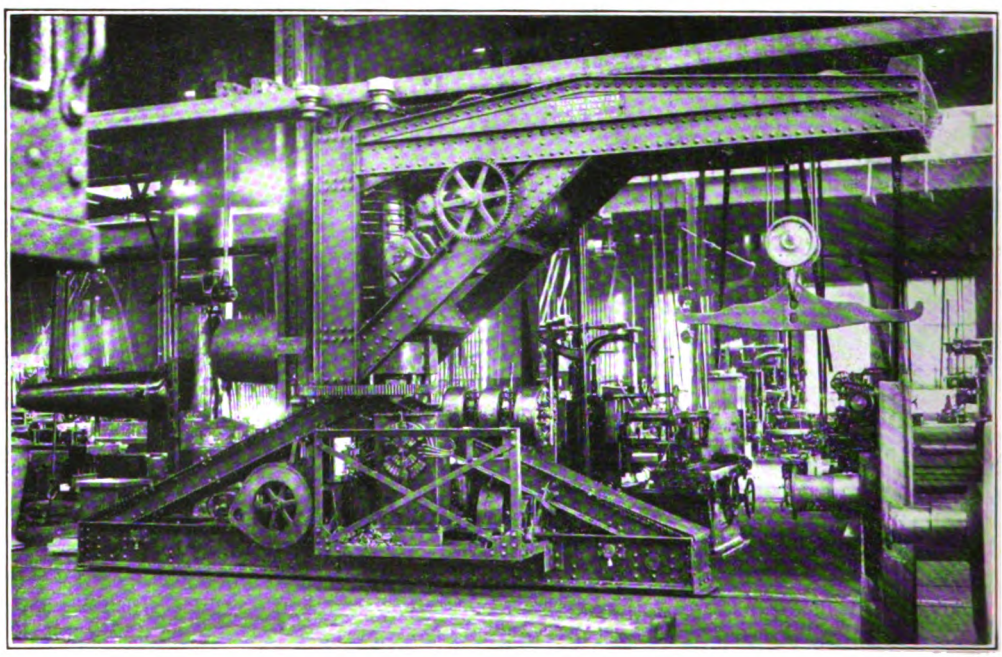

FIG. 29. WHITING ELECTRIC WALKING JIB CRANE OF 7½ TONS CAPACITY, WITH MOTORS FOR TRAVELING, SWINGING, RACKING, AND HOISTING

The third type of hoist brake is

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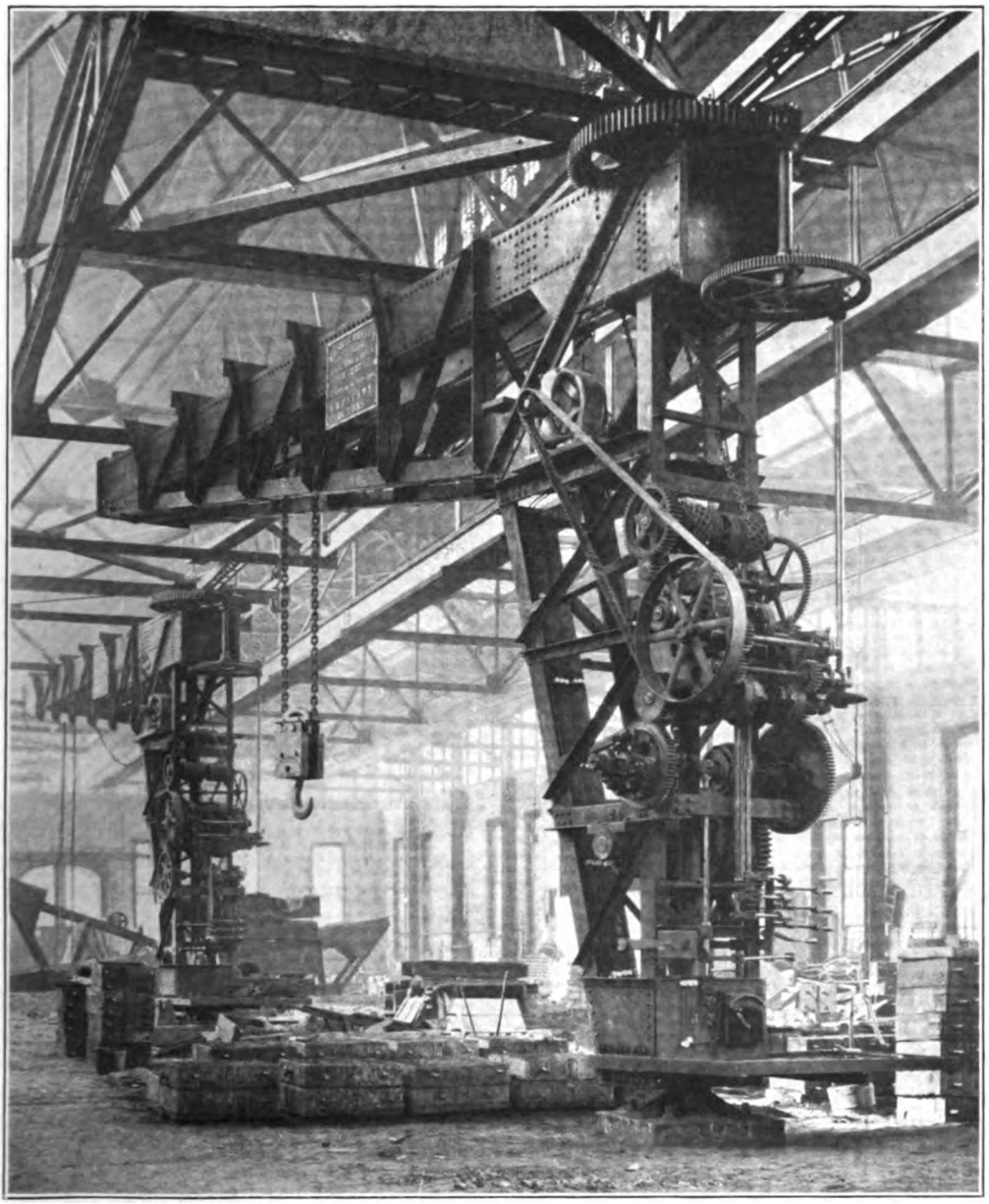

FIG. 30. SELLERS 10-TON SWINGING JIB CRANES IN FOUNDRY

called the dynamic brake and may be used in addition to the mechanical hoist brake or in place of it. Dynamic braking consists in utilizing the hoist motor as a generator to generate electric current when the load is being lowered, the load driving the motor. The current generated is dissipated in suitable resistances, and speed control is secured by varying these resistances. Dynamic braking will not hold the load suspended. If the motor current is interrupted and the motor brake loosened, the load will descend slowly under the influence of the braking action set up in the motor. Dyna-

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FIG. 31. THREE WHITING SWINGING JIB CRANES
The crane in the foreground has a chain-block and the other two compressed-air hoists. Indianapolis shops of the Cleveland, Cincinnati, Chicago and St. Louis Railway.

mic braking should be supplemented by a powerful band brake on the motor capable of being easily engaged at the will of the operator and of sustaining the full load of the crane safely. Dynamic braking is not efficient except in cases where the crane is working continuously, as in handling a magnet or a grab bucket.

A safety device that should be on every overhead crane is the limit switch; the function of which is to cut off the current automatically from the hoist motor as the hook approaches the top of its travel. This prevents the hook from being pulled up over the drum, a position in which the hook would be almost certain to drop the load. The writer has seen several accidents caused by the absence of the limit switch, one of them resulting in the serious injury of two men who were hit by a heavy chain dropped by the hook. The limit switch should not be connected so that it can be regularly used for stopping the upward motion of the hook. It should be made so that the operator is put to some inconvenience in turning on the current after it has been interrupted by the switch. This will prevent any tendency toward using this device except for emergencies.

Table I has been prepared in order to give a good idea of the range of sizes of standard overhead cranes and the speeds at which they operate. The data in this table applies specifically to cranes built by Pawling and Harnischfeger of Milwaukee, but the table does not include all the sizes built by this company, as several were omitted to avoid cumbersomeness.

WALL CRANES

Wall cranes are what might be called a cross between the overhead traveling and the jib cranes. They are of the jib type in general appear-

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TABLE I

Capacities and Speeds of Overhead Electric Cranes.

Size in tons of 2000 lbs.	Standard Hoisting Speeds in ft. per minute.	Bridge Travel Speeds in ft. per minute.	Trolley Travel Speeds in ft. per minute.	Size of Auxiliary Hoist in Tons.	Auxiliary Hoist Speeds in ft. per minute.
5	25 – 60 30 – 75 40 – 100	300 – 350 400 – 450	100 – 150		
10	20 – 50 25 – 60 30 – 75	300 – 350 400 – 450	100 – 150	3	30 – 75
15	17 – 42 20 – 50 24 – 60	300 – 350 350 – 400	100 – 150	3 or 5	50 – 125 40 – 100
25	10 – 25 12 – 30 16 – 40	250 – 300 300 – 350	100 – 150	3 5 10	50 – 125 40 – 100 25 – 60
40	9 – 22 10 – 25 12 – 30	250 – 300 300 – 350	100 – 150	5 or 10	40 – 100 25 – 60
50	8 – 20 10 – 25 12 – 30	200 – 250 250 – 300	100 – 150	5 or 10	40 – 100 25 – 60
60	8 – 20 10 – 25 12 – 30	200 – 250 250 – 300	100 – 150	10 or 15	25 – 60 20 – 50
75	6 – 15 8 – 20 10 – 25	200 – 250	100 – 150	15	20 – 50
100	5 – 12 6 – 15 7½ – 18	200 – 250	100 – 150	20	20 – 50
150	5 – 12 6 – 15	200 – 250	100 – 150	25	20 – 50

ance, but travel on rails on the wall. The jib or boom may be rigid or it may swing. The swinging-jib type is very useful in passing high obstructions or in passing a load suspended from an overhead crane. In order to make this possible the jib is hinged so that it will swing in a horizontal plane until it is parallel to the tracks.

Some of the details of the wall crane are shown in Figure 23 which illustrates an Alliance 10-ton wall crane in the shops of the Mesta Machine Company, Pittsburgh, Pa. With the trolley in the position shown in the upper crane, that is, at the end of the jib, the load conditions are most severe. The vertical load is carried by the wheels shown above the bottom of the crane, about one-fourth the total distance up. The load at the end of the jib causes tension in the diagonal rods, which in turn causes an outward thrust on the horizontal wheels at the top of the crane. In addition, there is a horizontal thrust in the opposite direction on the wheels at the bottom of the crane. It will be seen that, in addition to the vertical load such as is found in the overhead crane, there are two horizontal forces to be taken care of in the design of a building which is to carry a wall crane.

The lower crane in the same illus-

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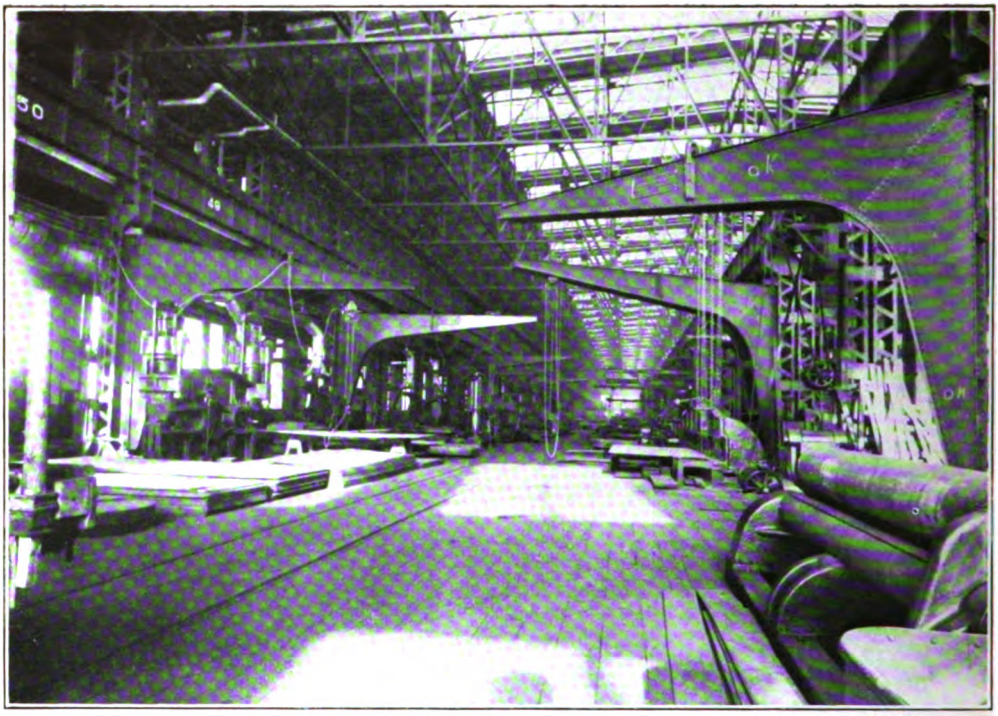

FIG. 32. MONTREAL BOILER SHOP OF CANADIAN PACIFIC RAILWAY, EQUIPPED WITH WHITING SWINGING JIB CRANES, SOME OPERATED BY COMPRESSED AIR AND OTHERS BY HAND

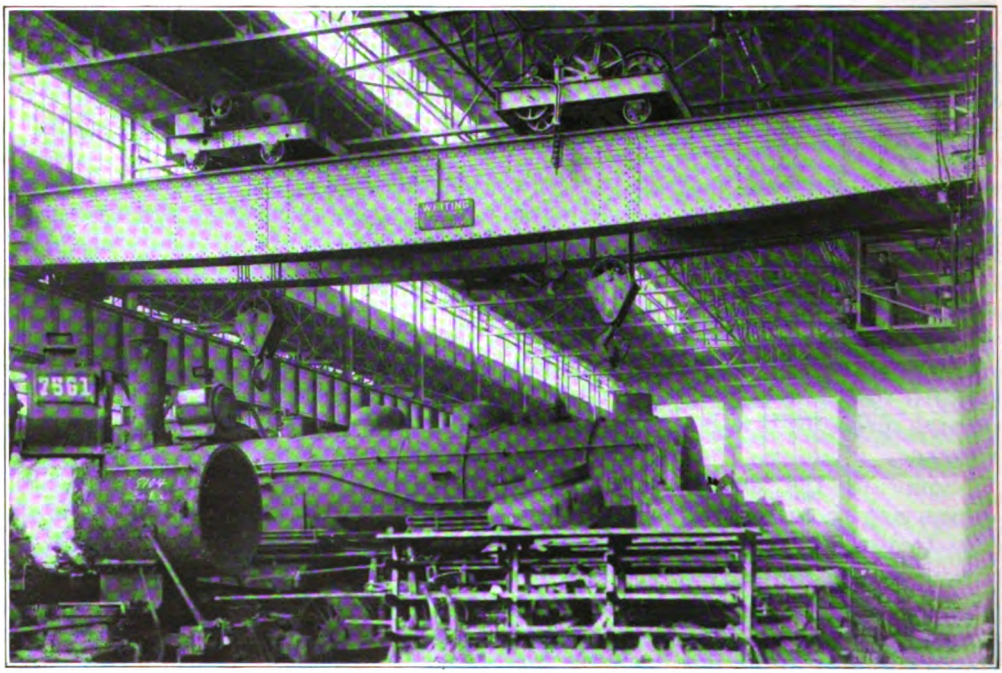

FIG. 33. WHITING ALTERNATING CURRENT CRANE WITH TWO 75-TON HOISTS AND ONE 10-TON HOIST, IN LOCOMOTIVE SHOP

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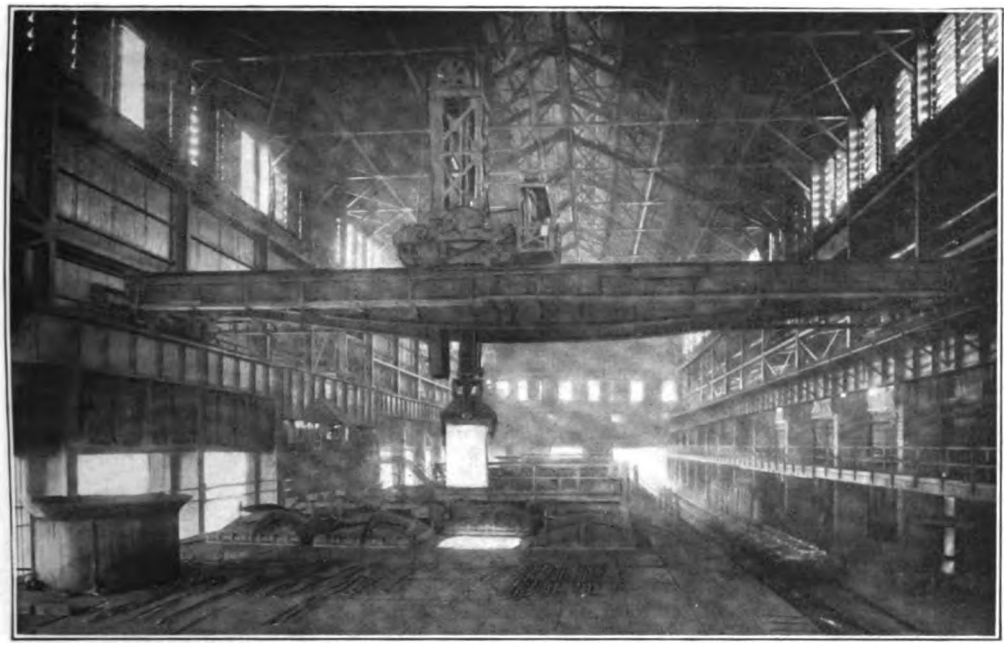

FIG. 34. SOAKING PIT CRANE BUILT BY ALLIANCE MACHINE CO., ALLIANCE, OHIO

tration also creates a load on the walls of the building in the same manner. There is this difference in these two cranes: the upper one is top-braced and is suitable for use where the headroom is not limited—its chief merit is that it gives unrestricted room under the jib; the lower crane is bottom braced, and is used where the headroom will not allow top bracing and where the room under the jib may be partially occupied by the diagonal brace.

The trolley, motors, gearing, etc., of the wall crane do not differ materially from the corresponding parts of the overhead crane except in such details as are influenced by the lighter loads handled and the more restricted spaces available. The wall cranes may be and are used for the same class of work as the overhead cranes. The most economical use of the wall crane, however, is in forming a secondary crane system to help out the overhead system. This is illustrated clearly by Figure 24, which shows a large shop with three overhead cranes supplemented by three traveling wall cranes. The overhead cranes handle the heavy work and the work on one side of the shop, while the wall cranes are used to serve the machines in groups, each crane caring for one or more machines, the number depending only on the character of the work.

The wall crane may be fitted with an I-beam trolley for light work, its operation being accomplished by means of pendant cords. Figure 27 shows such a crane, a two-ton machine built by Maris Brothers of Philadelphia. This company also builds a wall crane with double beams, with a trolley and hoist of the standard overhead crane type running on rails mounted on the tops of the beams. Either type may be operated from a cage, as in the other types.

There is another type of traveling jib crane which is very useful in shop work, the walking jib. This crane

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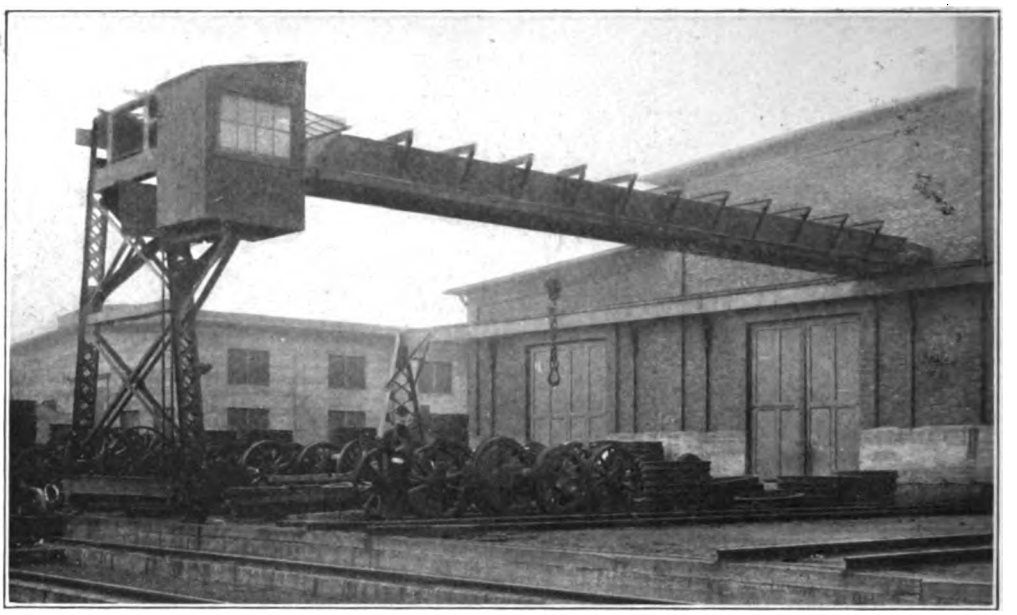

FIG. 35. MARIS CRANE WITH GANTRY LEG USED FOR YARD WORK
Trolley runs inside of bridge.

runs on rails on the floor and is guided by overhead wheels or rollers. The Sellers walking-jib crane in the Mt. Clare shops of the Baltimore and Ohio Railroad is illustrated in Figure 28. This crane, which has a capacity of five tons, has a swinging boom or jib with a radius of 15 feet 6 inches. The overhead structure is so built that the jib can swing in a complete circle when there are no floor obstructions to interfere. This crane operates at a fixed radius, but can reach any point within its radius by means of a combined swinging and traveling movement. The Whiting walking-jib crane, illustrated in Figure 29, has all the movements mentioned above and, in addition, has a motor for racking the load along the jib.

The stationary swing-jib crane has a wide application in certain classes of shops or for certain kinds of work. They are used frequently in foundries for handling flasks during the molding period and for pouring groups of molds. Figure 30 shows a Sellers ten-ton swinging jib in a foundry. This machine, which has a radius of thirty feet, is drawn by a single constant-speed motor. It has two hoisting speeds, and the load may be lowered either by power or by hand.

It is often convenient to place light swinging-jib cranes on the posts of the building structure, each crane to handle material on and off a machine or group of machines. A system of this type is shown in Figure 31. The cranes are top-braced, giving a clear space underneath, and the trolley-chain hoists on the I-beam jib constitute a flexible machine to be manipulated by hand. The two distant machines in the illustration have air-cylinder hoists. This type of hoist is inexpensive and rapid, but cannot be operated with such a high lift as the chain-block hoists. In order to overcome this difficulty the air cylinder is sometimes placed in a horizontal position along the jib, or, where the headroom is sufficient, it may be placed in a vertical position above the jib.

In certain shops, where the material under manufacture progresses

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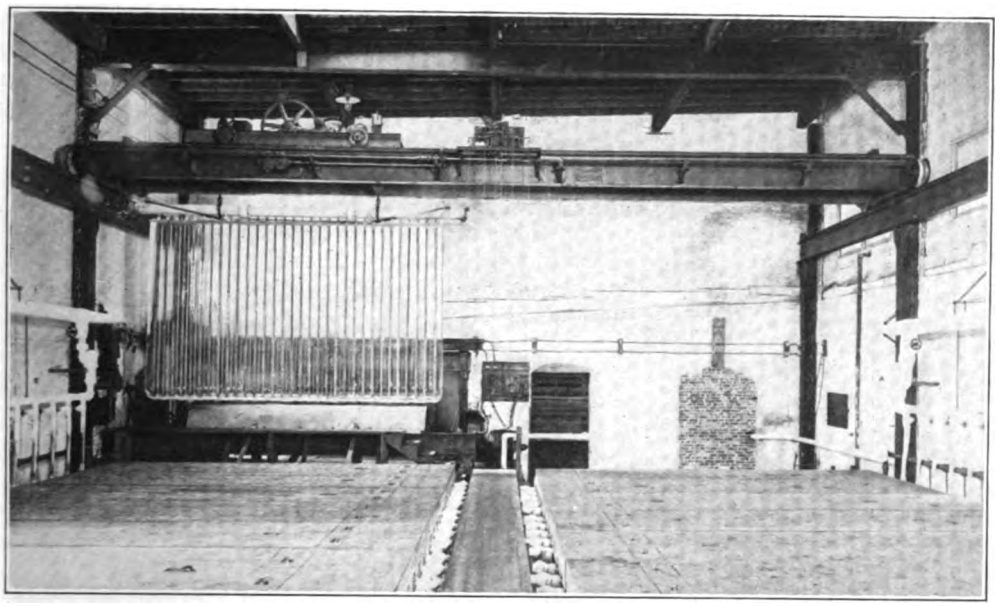

FIG. 36. MARIS ELECTRIC CRANE OPERATED BY MEANS OF PENDANT CORDS
Crane removes plate ice from two rows of tanks.

from one end of the shop to the other, swinging-jib cranes may be used to better advantage than overhead cranes. Such a shop is shown in Figure 32. This is the Montreal boiler shop of the Canadian Pacific Railway which contains a series of Whiting three-ton swinging-jib cranes arranged in rows on either side of the building. Some of these cranes are equipped with chain hoists operated by hand, while others have hoists driven by compressed-air motors.

While it is impossible in this paper to cover fully the question of the application of cranes to all classes of plants, it might be of interest to show a few special applications of the overhead crane. In Figure 33 is shown a two-trolley crane built by the Whiting Foundry Equipment Company for a locomotive shop. The span of the crane is 67 feet 11 inches. It has two 75-ton hoists and one auxiliary hoist with a capacity of 10 tons. This combination necessitates six motors to operate the crane. Three-phase, 25-cycle, alternating current at 550 volts is used.

The Alliance soaking-pit crane, in Figure 34, is a type perfected for one specific purpose, that of placing steel ingots in and removing them from soaking pits or furnaces. The jaws which grasp the ingot are on the bottom of a vertical plunger for the sake of rigidity. This plunger, which has a vertical travel of about ten feet, is operated by an electric motor, and necessitates a high superstructure for the trolley. The jaws are also operated by a motor. The rest of the machinery is similar to that of the ordinary overhead crane.

It is often desirable to use an overhead crane for yard work. When this is done it is sometimes convenient to build a runway or bridge track on existing structures. Often this cannot be done; but frequently a building may be utilized at one end of the crane, as in Figure 35, which shows a Maris crane with an elevated runway, one end resting on a building and the other on gantry legs. In this

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particular installation it was desirable to keep down the overhead clearance, so the trolley was put inside the bridge girders. To prevent any possible spreading of the girders, yokes of the kind shown were used.

The final illustration for this chapter shows a Maris electric crane which was built especially for handling artificial plate ice. The crane serves two rows of tanks, the operator's walk being located between the rows. The trolley may be moved from one side to the other as required. In this particular crane the machinery is exposed, but in later types built by this company the hoisting unit is enclosed to mitigate the effects of dampness which is ever present in a plant of this kind and also to prevent contamination of the ice by oil dropping from the crane.

How to Create Industrial Leaders

By Henry L. Gantt

Much is being said and written these days about the scientific selection and training of employees, but the selection of their leaders has been left largely to autocratic methods. Mr. Gantt believes that those organizations will succeed best that can select their leaders in the most democratic manner possible.—The Editors.

Industrial leadership, in my opinion, should be emphasized over all other elements that make for industrial progress. What statesman or warrior ever produced such permanently far-reaching results in the world as any one of the great industrial leaders so well known to us—Watt, Fulton, Whitney, Stephenson, Morse, Bessemer, Siemens, Bell, Edison, Westinghouse, Wright? These great inventors were pioneers, but the host that developed their inventions to the high state of perfection which they have attained are not less valuable members of society. Indeed, we have today so much undigested and unutilized knowledge that I am inclined to think that the man who shows us how to use it satisfactorily is quite as important as he who discovers it.

It is these great men and their followers that during the past forty years have absolutely revolutionized the conditions of life. Forty years ago the great majority of our people lived on farms, and were, to a large extent, themselves producing the necessities of life; today they are collected into large communities and engaged in special occupations which do not directly supply their needs. In fact the great mass of people buy almost everything they use. This result has come to pass because we have changed from an agricultural community, largely, to a manufacturing, or industrial community.

This progressive change, which is still rapidly going on, has introduced problems for the solution of which there are no precedents. Modern industrialism is so modern that its greatest problems have hardly been clearly grasped even by those who have given them most study.

Twenty years ago the financier thought he had found a panacea for most of the evils which the new developments began to show, in his combination of industrial plants into large organizations. Undoubtedly he did succeed for a while in securing a larger profit for the promoters of the organizations; but the most import-

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ant problems, those concerning the relations of employer to employee, have not been solved any better by the large corporation than by the individual employer. In fact the large corporation seems in many cases to have accentuated the troubles which had arisen. This has undoubtedly been due, in a large measure, to the lack of personal touch between employer and employee, which seems impossible in the large corporations, where there was at first an apparent tendency to ignore entirely the human factor as an influence in industrial work.

Men who promoted these large corporations were in many cases financiers or merchants, who previously had dealt almost exclusively with money and goods. They had bought in the cheapest markets and sold at the best price they could get. Their natural tendency, therefore, was to apply to the purchase of labor the same rules which they had applied to the purchase of materials, namely, to buy it as cheaply as possible. The great difficulty which stood in the way of accomplishing this result was that there was no exact means of measuring the labor received, and the best that could be done was to buy a man's time on the theory that time consumed was a measure of labor performed. While this is in a measure correct if the workman feels that he is being equitably rewarded for the work done, it may be far from correct when he does not have this feeling. When he realizes, as is often the case, that the employer, taking advantage of his necessity, gives him the smallest hourly rate he can be hired for, he naturally does only just enough work to hold his job.

Moreover, there has seldom been any attempt to keep a record of the work any man did in order that a more equitable compensation might be accorded him; and, whether he did much or little, he was accorded the hourly rate of wages common to his class. The railroad companies, perhaps more than any other organizations, have offended in this manner, and the rates of wages, which they were willing to pay for different classes of workmen were not only fixed by employers, but maintained with all their power. A mechanic, therefore, had but little chance of getting a higher compensation than his class rate, no matter how industrious or conscientious he might be.

The introduction of piece work, by which the workman was paid for the work he did, instead of the time he worked, promised better results; but as piece prices were commonly set on a basis of what had been done by a man dissatisfied with his daily wage, it soon became clear that the men could do much more work than had been done, and earned correspondingly higher wages, with the result that *the employer reduced the price per piece.* This "cutting" of piece prices was common practice whenever the workman earned much more than his class rate; and the capable workman, recognizing the impossibility of increasing his compensation through more or better work, soon ceased to make any effort in that direction, and devoted his spare time to the organization of a union with the object of advancing the class rate.

A careful consideration of this subject will show that the employers who insisted on class rates, irrespective of the ability and service of the individuals themselves, thus furnished the strongest incentive for the formation of the unions, which have been, and are now, so effective in increasing the class rate, and which have done much for the amelioration of the condition of the workmen.

The neglect on the part of the em-

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ployer to recognize individual ability, and to reward it correspondingly, coupled with his effort to secure workmen at the lowest possible daily wage rate, forced the workman to concentrate his attention on the wages he received, and made him comparatively indifferent to the amount of work he did. In other words, both employer and employee ignored to a large extent the amount of work done, and devoted their efforts, the one to paying as little wages as possible, and the other to getting as much as possible for the work he did.

Under such conditions it is not surprising that costs should be high, and that there should be antagonism between employer and employee. It is, of course, impossible to pay permanently high wages unless a large amount of work is done for those wages. At first the workmen apparently did not see this, nor did the employer see that there was no advantage to him in forcing workmen to work at low wages, for by so doing he failed to get a proper return even for the small wage he paid. *Both employer and employee thus put a premium on inefficiency.*

Within the past ten years this portion of the subject has been given much more attention, and it is becoming recognized among the most progressive manufacturers of the day that the ratio between the wages paid and the work done is more important than the absolute amount of wages paid, and that the absolute amount of work done is more important than either.

Moreover, it is becoming recognized that the good man at high wages not only does more work per dollar of wages than the poor man at low wages, but better work. In the most prosperous factories, and those turning out the highest grade of product, we invariably find high-grade, well-paid workmen; while in those factories which are making but little profit, and where the work is of a poor quality, the workmen are usually poorly paid and of low grade. The unsuccessful manufacturer, when this matter is pointed out to him, too often says that the successful owner can afford to hire good men at high wages because he is successful. Evidence seems to indicate, however, that he is successful because he hires the good men at high wages, and that the policy of paying satisfactory wages has been more influential in producing low costs than any other item.

This leads us to the broad subject of administration, and we naturally ask if there are any general principles on which successful business administration is based. This subject has been much discussed, and the factors ordinarily entering into the success of an industrial enterprise are so varied that it is often hard to say what has been the most important one in producing the success obtained.

If there is any one principle which more than any other is influential in promoting the success of an organization it is the following:

The authority to issue an order involves the responsibility to see that it is properly executed.

The system of management which I advocate is based on this principle, and eliminates "bluff" as a feature in management, for a man can only assume the responsibility for doing a thing properly when he not only knows how to do it, but can also teach somebody else to do it.

The fact that our system of management sooner or later exposes the bluffer makes its installation in a factory very difficult, for there is in every organization, especially when it is large, a surprisingly large pro-

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portion of bluffers who are smart enough to see promptly that under such a principle they will not last very long. Moreover, the higher up they are, the quicker they are affected.

Professor Edw. D. Jones, of the University of Michigan, recently wrote a series of articles in THE ENGINEERING MAGAZINE, now published in a book entitled "The Business Administrator," in which he attempts to segregate the principles of administration. While his success has apparently not been entirely complete in this matter, yet he has made clear some very important facts; the first of which is, that administration means administration of human affairs, and that the one common element in all enterprises is the human element. The materials and forces with which we deal are comparatively unimportant, being subject to laws which in general have been pretty definitely determined. Our knowledge, however, of the best methods of handling men is still far from complete. In order to collect data on this subject, Professor Jones has studied the great leaders and administrators of the past of whom history gives us an account. He has developed the fact that in the past great success of co-operative human effort has been attained only under great leaders. Even a casual study of industrialism today indicates that leadership performs a most important function.

A few years ago there was a strong feeling in this country that the most important element in any enterprise was the financial element, and that if there was only money enough available, nothing else mattered very much. This idea has not held good, for we are beginning to realize that there is an end to the largest bank account, and we are rapidly coming to the conclusion that neither money nor organization will permanently insure success without proper direction. It is therefore imperative upon us to study leadership and to find the laws on which successful administration is based.

The absolute necessity for proper leadership in industry thus becomes clear, and we begin to see a close parallel to leadership in war, the necessity for which today is becoming increasingly apparent. History has given us very accurate accounts of great generals and it is of this class of leadership that we can learn most. After a little study, we realize that leadership in war and in industry is not only based on the same principles, but is equally important. It seems, therefore, that we should give this subject the attention it deserves, and profit by the account that history gives us of great warriors. Industrial leadership has been largely overlooked in the past for the reason that accidental conditions have in many cases been quite as effective in securing wealth as leadership. Such opportunities are, however, no longer numerous, especially in our industries, and a study of industrial leadership is forcing itself upon us.

Just as war is the great training school for those who are to make war, so industry is the great training school for those who are to create industry. Leaders in war and in industry hold the same relative importance in their respective spheres. If this is the case, it is well for us to see what the greatest warrior of modern times has to say about the importance of leadership in war, and thus arrive at some appreciation of the importance of leadership in industry. Napoleon said:

> In war men are nothing; it is the man who is everything. The general is the head, the whole of any army. It was not

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the Roman army that conquered Gaul, but Cæsar; it was not the Carthaginian army that made Rome tremble in her gates, but Hannibal; it was not the Macedonian army that reached the Indus, but Alexander; it was not the French army that carried the war to the Weser and the Inn, but Turenne; it was not the Prussian army which, for seven years, defended Prussia against the three greatest Powers of Europe, but Frederick the Great.

The historian in making this quotation stated that Napoleon reiterated a truth confirmed by the experience of all ages, in saying that *a wise direction is of more avail than overwhelming numbers, sound strategy than the most perfect armament.* Similarly in industry—*a wise policy is of more avail than a large plant; good management, than perfect equipment.*

The historian goes on to say:

Even a professional army of long standing and old traditions is what its commander makes it; its character sooner or later becomes the reflex of his own; from him the officers take their tone; his energy or his inactivity, his firmness or vacillation, is rapidly communicated even to the lower ranks; and so far-reaching is the influence of the leader, that those who record his campaigns concern themselves but little, as a rule, with the men who followed him. The history of famous armies is the history of great generals, for no army has ever achieved great things unless it has been well commanded. If the general be second-rate, the army also will be second-rate.

These facts in military history have their exact counterpart in industrialism, for *THE FACTORY INVARIABLY REFLECTS THE MANAGER.* The real problem of today is, then, how to select and train, or rather how to train and select our industrial leaders.

Professor Jones states the indisputable fact that *the possession of wealth and hence power, does not necessarily fit a man for leadership.* There is a general feeling, however, that because our industries have in the past been directed in an autocratic manner, that autocracy will continue to be the rule, and that there is apparently no escape from it. This feeling seems to be quite wide-spread, and to be substantiated by the marvelous industrial development of Germany under autocratic rule. While it is possible that autocracy in industry is the final stage, I do not think the case is by any means proven. Has not the development of industrial organization been in a large measure parallel to the development of political organization? In both, we had individualism; then paternalism; and then tribalism, or something approximating it; next we had autocracy. In our political organization we have passed one step beyond—we, in this country, believe in democracy, and the great struggle now going on in Europe is largely a question as to whether democracy or autocracy shall be the final phase in the old world.

The marvelous efficiency of Germany as an industrial and military nation has claimed the attention of the whole world; but we must realize that Germany is the only nation which has made any serious attempt at national organization of industry. When, therefore, we compare the industrial condition of Germany with the industrial conditions of any other country, we are not comparing one organization with another, but a highly perfected organization with lack of organization.

In the summer of 1913, three hundred members of the American Society of Mechanical Engineers visited Germany at the invitation of the *Verein deutscher Ingenieure.* We spent three weeks touring the country and visited most of their great cities, where we were entertained with the greatest possible hospitality, and had thrown open to us many of their most successful industrial plants.

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We were much impressed with what we saw, and the universal prevalence of system and order elicited our unbounded admiration.

When, however, we came to the consideration of the industrial plants as units, we were in almost entire accord that, with the exception of a few industries, plant for plant, America had nothing to fear from Germany.

The greatest power in Germany in the past has been that of their autocratic rulers, who not only encouraged scientific development, but demanded it, and used all the power of the state to further it. This tendency rapidly brought Germany to the front in the scientific world, and the application of the scientific knowledge thus attained has brought her to the front in both the industrial and the military world. How effective autocratic power may become in the industrial world when guided by science we have long known, but it is only recently that we have realized how effective such a power might become in a military world under the same guidance.

The goal for which Germany is now striving by military power seemed to many of us much more likely of attainment through their industrial development, for the rapidity with which industrial development can be carried on by autocratic means is far greater than that which is possible under democratic methods. On the other hand, the results obtained under democratic methods are far more permanent and less liable to be perverted to false ends.

This leads us, therefore, to ask if autocracy in industry is not just as much a phase in industrial development, as we in this country consider it to be in political development.

As a matter of fact, during the past ten years it has been my effort to introduce methods of equal opportunity into industry, and to select leaders in the most democratic manner possible. I am pleased to say that the efficiency of the organization thus produced has seemed to be almost in direct proportion to the success of introducing democratic methods of selecting leaders.

Too little work has been done in this line, and there are too few results available to allow us to make any very strong statements, but the success so far attained is such as to make us feel that we are on the right track, and that the nation which first does away with autocracy and special privilege will take the lead in industrialism.

The scientific method thrives best when all have equal opportunity, and our chance of getting proper industrial leaders is far greater when we have a whole people to choose from than if they are to be selected from any one class.

Professor Jones' emphasis of the fact that in all problems of administration the most important element is the human element, compels acceptance of the democratic idea, for no manager can attain the highest ideals unless he is thoroughly familiar with all the elements with which he has to deal. It is general experience that unless men are studied from a democratic standpoint, the student fails to get a proper appreciation of the human element.

This brings me to what I consider one of the most important activities of the Sheffield Scientific School, namely, the Social Service Work which was described in Professor Roe's paper before the American Society of Mechanical Engineers at their meeting in St. Paul in June, 1914.

The title "Social Service Work" is a good one. All of the engineer's work is *service work*—in that he

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makes his living by serving somebody, and much is *social service work*, for in much of what he does he serves the community. This is not exactly the meaning of the title of Professor Roe's paper, but it gives an opportunity to emphasize the fact that in an organied community we all earn our living by giving service. When one man hires another it is his service he wants. When a man buys a machine it is the service of that machine he wants—not the specific machine—any other machine which could perform the same service equally well and equally economically would do.

In a civilized country we are all buying and selling service. The bread we eat, and the coal we burn are available to us through the service of many people. Likewise our value to the community is measured by the service we render, and in the long run our reward is apt to be in proportion to that service.

"Social Service Work," although narrower in meaning than what I have described, is not only a most excellent method of bringing together the workman and the future leader, but of producing in the mind of the student a conception of the pleasure and value of serving. This is a comparatively new idea, and its growth is fostered only under democratic conditions. Under autocratic methods to render service is a sign of inferiority; the man of power compels the service of others. Under democratic methods the man of power uses that power to serve others. Under autocratic rule the man in authority is a master; under democratic rule he is a servant.

Engineering schools have successfully taught the laws of materials and forces, and the methods of adapting these materials and forces to the use of man; but they have almost entirely disregarded the human element, a knowledge of which is absolutely essential for the proper utilization of any mechanisms which the engineer may contrive. If we would direct successfully the operation of any mechanism, we must have as complete knowledge of the men who are going to operate it as we have of the mechanism itself, and the Social Service Work, is, to my mind, the best available method of supplementing the knowledge obtained in the classroom.

Without an intimate knowledge of the workman, a college graduate is too apt to assume that the workman, because he has not the same kind of knowledge the college man has, is necessarily ignorant and a fit subject for contempt. A little association with him, however, soon dispels this idea, for the college man finds out that the workman's knowledge, although quite different from his own, is very extensive, and embraces subjects of which he is entirely ignorant. The workman has indeed a great deal of knowledge, much of which is far more practical and better suited to his needs than that the college man can give him. Moreover, the workman readily recognizes that the college man knows but little about those subjects with which he is most familiar, and the contempt which the college man is apt to get for the workman before he knows him is only a small fraction of the contempt which the workman frequently gets for the college man.

The Social Service Work which has attracted the interest of so many men is certainly the best way which has yet been devised to enable the college man and the workman to learn and to appreciate the good qualities of each other. The college man is too apt to feel that by reading a few books on industrialism or political economy, he has acquired a

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broad knowledge of working conditions, but he very soon finds that many of the general principles so widely exploited in such books produce, in special cases, results which are not even hinted at in the books.

The fact that the average wage rate in an industry is high does not at all prove that there may not be quite as much, or more, suffering in that industry than in an industry in which the average wage rate is much lower.

I have confidence that some of the men trained in industrial service work will thereby be enabled to see more clearly the proper relations between employer and employee, and in the near future will contribute much to the solution of our industrial problems.

In the past much emphasis has been laid upon the importance of our "captains of industry" and other men who have attained great wealth through industrial enterprises. A few years ago their methods were extensively advertised in the magazines, and they were as a class pretty generally looked up to.

Times have changed, however, and the world has advanced. Mr. Rockefeller's method of acquiring his fortune was not greatly different from the methods pursued by other men in his day. He was only just a little more shrewd, and perhaps a little more ruthless. The same thing may be said of Mr. Harriman and Mr. Carnegie, but I believe the time is past when the methods of these three prominent figures can ever be duplicated. The industrial leader of the future must practice methods which are approved by the people, and they must be such as not to take unfair advantage of anybody. The term "unfair competition" has gained much publicity of late. It is similar to spiking a man in a game of baseball.

As was said before, the world advances through leadership, and I feel that it is just as much the function of our engineering schools to train our industrial leaders as it is that of our military schools to train our military leaders.

This being the case, our engineering schools should have a broad knowledge of all matters affecting our industrial system.

Until recently our financiers, on account of the power of their wealth, have exercised almost complete control of our industrial institutions, and have too often dominated not only the financial and selling policies, but the policy employed in handling workmen. Of the first two subjects they frequently had quite a good deal of knowledge, but it is seldom that their knowledge of industrial conditions was such as to enable them to formulate an intelligent policy where the workmen are concerned. This fact is coming to be more and more recognized, and the handling of the workmen is being delegated more and more to those who have made a study of the subject.

The fact, as stated before, that our industries have been handled in general in an autocratic manner is no sign that they will continue to be so handled, and almost every day we see increasing symptoms that people are realizing what true democracy means.

None of us today really believe that men are created equal, but we do believe that they are entitled to an equal opportunity. Moreover, developments seem to indicate that the more nearly we can accord men equal opportunities for advancement, the more prosperous the individuals and the country as a whole will be.

This seems to make incumbent upon the engineering schools a thorough study of all industrial conditions. Books on political economy

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are all very well, but in most cases they were written before the advent of modern industrialism, or by people who have too many times studied it from the academic standpoint. Every opportunity, therefore, should be given to the student to study the conditions at first hand as they exist today in our industries, for by such a course only can the industrial leader of the future acquire such knowledge as will enable him to inspire confidence in those whom he will be called upon to lead.

As I look back over my own history I can pick out five or six men who have influenced my life more than all others combined; some of these were school teachers, some college professors, and others were in industry. Each of my readers may have marked influence on the lives of a large number of workmen. People learn but little from what they are told, but they readily imitate what appeals to them. If, therefore, a man would be a leader he must know thoroughly the people whom he would lead, and be able to shape his actions in such a manner that they will not only be understood but thoroughly appreciated by his followers.

In a paper on "Training Workmen in Habits of Industry and Coöperation" read before the American Society of Mechanical Engineers in December, 1908, I made the following statement: "The general policy of the past has been to drive, but the era of force must give way to that of knowledge, and the policy of the future will be to teach and to lead, to the advantage of all concerned." I did not then realize how rapidly my prediction would come true.

As an illustration of the difference between leading and driving, I may cite an incident that occurred in my presence in a steel foundry. For the benefit of those who may not know, I may say that steel is poured through a nozzle in the bottom of a ladle, and not over the top as is the case of cast iron. This nozzle is closed with a plug, but for one reason or another this plug sometimes does not close the nozzle entirely after pouring a mold, and the steel leaking out splashes over the ground and the flasks, not only making the neighborhood of the ladle a very hot place, but setting fire to anything combustible within reach. In order to protect himself from being burnt, should a "bad shut off" occur, the ladleman usually wears thick woolen clothes, including, if possible, an old overcoat.

On the occasion in mind the "shut off," while the ladle was being taken from one mold to the next, was very bad, and the splashing and the heat of the molten steel were almost unbearable.

It must be understood that a leaky nozzle is very apt to "freeze" up, not only leaving the molds unpoured, but leaving the steel in the ladle in a large solid mass which it is very difficult to utilize. Moreover, the flasks to be poured are usually needed by the molders the next day, so if they are not poured it is usually impossible to get a full day's work molded the following day.

Notwithstanding these facts, which the ladleman knew perfectly well, he decided that he could not face the heat of the steel from the leaky nozzle, and left his ladle hanging on the crane with the steel running out.

The superintendent, who was standing near, did not say anything, but, signaling to the craneman to move to the next mold, went up and, taking the handle of the ladle, began to pour the metal. Before he had finished pouring the first mold the ladleman came up, took the handle and poured the remainder of the heat.

The flying sparks had ruined a suit

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of clothes, but the superintendent had established himself in the estimation of the workmen, and the ladleman as far as I know never again forsook his post.

This is a good example of physical leadership, which, while absolutely essential to any kind of success, can only affect the few people who are immediately concerned. There is another and higher leadership, that of the intellect, by which the methods and thoughts of one man may affect the whole civilized world. Industrial leaders who have most prominently attracted our attention in the past are those who have, by their inventions or their direction of activities, accumulated large fortunes; but none of these are as great as the man who by the force of his intellect leads people throughout the civilized world to benefit themselves and others. Such a man was Frederick Winslow Taylor, who, in his determination to eliminate error and to base our industrial relations on fact, set an example which will have an effect all over the world.

His great contribution to the world's work was to substitute knowledge of human activities for opinion as a basis of action.

His insistence that all industrial questions could be best answered by a scientific investigation was at first scoffed at by many of our industrial leaders, and it was nearly twenty years before he got much support. Now, however, at the end of thirty-five years his persistence is bearing fruit so rapidly that the whole industrial world is undergoing a revolution due to his ideas.

His death cut short the activities of a man who had the welfare of his fellow man at heart, and who spent much of his life in trying to establish a basis on which the relations between employer and employee could be made mutually satisfactory.

When he began his work, almost all such relations were established by opinions. Today there are few industries in which fact has not supplanted many opinions.

He had the feeling that waste was a crime, and that efficiency in work was a duty not only to ourselves and to our employers, but to the community at large.

His name will live as that of a man who could rise above individual cases, and grasp general laws that would make the happiness and prosperity of all.

We cannot all be Taylors, but we can each of us add our little mite to the sum of industrial knowledge with the confident expectation that it will ultimately be used for the benefit of mankind.

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EDITORIAL COMMENT

MR. ALEX. DEL MAR has written so excellent, indeed so helpful, a paper upon the subject of trading with South American countries (see page 354) that it seems a pity to have to dissent from any part of what he has said. But when he resurrects the ghost of a "ship subsidy," upholds it as the only possible solution of our present South American problem, and frankly says "It remains the only practical remedy"—then we must dissent. For a "ship subsidy" has become a very stench in the nostrils of the American people, and it has been thrown out of Congress so often and so emphatically that it is worse than useless to even talk about it any longer.

Nearly two generations have passed and gone since the American people knew or cared anything about a merchant marine. Naturally enough most of the living generation are completely at sea upon the whole subject. Only close students of the past history of our merchant marine are aware of the fact that for years before our Revolutionary War, and from Washington's first term clear up until the triumphant conclusion of the War of 1812-14, the American people fought, bled, and actually died for "freedom of the seas." The lessons of those two heroic wars, and the dauntless Independence and bravery of our American forefathers, finally taught British statesmen that we knew precisely what we wanted—and that we meant to have it! Then it was that American ships began to sail the seas to every port and clime; then it was that American clippers became famous in song and story; then it was that our overseas commerce began to rise by leaps and bounds; and then we forged ahead so fast that by 1860 we were abreast of England in the carrying trade of the World.

And why was this?

Simply because we had both the forests and the shipyards, we could build cheaper, build faster, sail faster, pay higher wages than had ever been known before in over-seas commerce —and thus only could we challenge the competition of the world in over-sea freight rates.

Now again we are face to face with almost identically the same problems that confronted our forefathers in 1814. We have the coal, we have the iron ore, we have the blast furnaces, we have the steel mills, and we can manufacture iron and steel cheaper than any other people on earth.

"It is not the lowest, but the highest-paid labor, with scientific management and machinery, which gives cheapest products. Some of the important staple articles made in Britain, Germany, and America, are produced cheapest in the last, with labor paid double."

—*Andrew Carnegie.*

We have skilled mechanics, at high wages, operating automatic and semi-automatic machinery, and we can beat the world in all standardized production! And because of our genius in invention, because of our exhaustless resources in organizing capacity, and especially because of our unmatched industrial leadership, it is perfect folly to suppose that we cannot build steamships in competition with all the world—precisely as we build sky-

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scrapers, steel bridges, locomotives, automobiles, and what not.

"Our capacity to produce has developed so enormously and our products have so multiplied that the problem of more markets requires our urgent and immediate attention.

"What we produce beyond our domestic consumption must have a vent abroad.

"The period of exclusiveness is past. The expansion of our trade and commerce is the pressing problem.

"No narrow, sordid policy will subserve it."

—*Wm. McKinley, on the day of his death.*

"Where there's a will, there's a way." And now that the American people are happily turning their attention to the pressing need of upbuilding the American merchant marine, we may be sure that they will not be long about finding the way. As the first step leading that way, we commend to the thoughtful consideration of all believers in ship subsidy the brief and prophetic paper contributed to these pages last month by Mr. William L. Saunders under the title "Ships and a Navy for the Americas." As Mr. Saunders pertinently suggests, we already own the Panama Steamship Line; it has been in successful operation for ten years past; it has accumulated assets amounting to more than twenty millions of dollars; several of its ships are already available for trade with Central and South America; more should be added without delay to provide sorely needed transports, colliers, and supply ships for our army and the Greater Navy which we *must* now have—in sheer protection of ourselves, and of the immortal Monroe Doctrine. And as Mr. Saunders wisely observes: "Why not take advantage of the opportunity and spend money in this field, which is now open to us, and thus gain experience which might fit us more thoroughly for permanently establishing a merchant marine."

"Out of all these prophecies and forecastings of the European mind, there rises the complete and splendid vision of a boundless new state, whose language shall be the English tongue, whose citizens shall be a new cosmopolitan race, whose industry and commerce shall flourish as those of Tyre and Sidon never did, whose power shall be irresistible on sea, and the very vastness of whose territory and political unity shall make it invincible."

—*Cardinal Aleman of France, in* 1778.

IT seems to us rather an act of folly for an individual to set himself up as a judge upon the possible actions of twenty-three of the most prominent engineers of the country, and condemn as useless such a body as the Naval Consulting Board, within thirty days after the first formal organization of that Board. Incredible as it may seem, yet such has been actually the case. On October sixth the members of the Board first met and discussed ways and means by which the Board as a whole might work most effectively for the welfare of the Navy and the good of the Nation. One of their first actions was that the Board should not be termed either an "Inventions" or an "Advisory" Board, but a "Consulting Board"—quite a different thing. Yet almost within the month, November eighth, to be exact, a self-appointed judge—a patent lawyer who served as ensign in the Navy from the year 1867 to the year 1869 and is therefore a duly qualified naval expert in the year 1915—states most decidedly "that the Naval Advisory Board as now created is not adapted to rendering useful assistance to the Navy." He comes to his conclusions because, first, only eleven societies were selected "to solve 'big naval problems'" instead of the two or three hundred or more in the country, although he grudgingly admits that the Board "includes *some* gentlemen of high professional eminence;" second, a Board of inventors is constitutionally incapable of perceiving merit in the inven-

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tion of another; and finally, the Navy, being composed of experts anyway, is absolutely in no need of advice from anyone, least of all from civilians. Furthermore, he argues that a five million-dollar laboratory is untold folly.

Before and after the Board had its first meeting we had the opportunity of conversing with a number of its members, and took pains to study their careers. We found that almost every man is a member of several other societies than the one by which he was elected; at least six are graduates of the Naval Academy and are members of the Society of Naval Architects and Marine Engineers, and at least four have had active experience in the Service. We found that almost every man is either the head of or an important factor in some of the largest industrial institutions in the country, and therefore must have had repeated occasion to pass upon the merits of the inventions of others. And we found that every member is duly impressed with the fact that naval officers of today are highly competent and highly specialized experts, and that therefore the Board can be of best service in a purely consulting capacity.

We realize, however, as the critic above referred to apparently does not, that warfare of today is a vastly different thing from warfare in the Sixties and that many new problems have arisen which are equally new to the highly competent naval officer. We realize still further that when a new problem arises in any large corporation an outside consulting engineer is generally called in to render an opinion, regardless of how many trained experts are to be found within the corporation itself; and, last but not least, we realize that the modern battleship represents a cost of something between five million and fifteen million dollars, and that its total loss can be affected with surprising ease in a modern naval encounter. If, therefore, a five million dollar laboratory does nothing else but perfect some scheme for saving only one battleship from destruction, it will have paid for itself. There seems to be some doubt even among the members of the Board as to whether one million dollars will not provide a laboratory sufficiently equipped for experimental work. Frank J. Sprague, President of the Sprague Electric Works, and a member of the Board, in these pages last month thought that possibly one million dollars would be sufficient. Surely, in view of the possible benefits to be derived Congress should not cavil at even the higher figure.

As to the importance of the organization of such a Board, the opinion of M. Albert Thomas, Under Secretary of State for Artillery and Munitions for France, should be given great weight. M. Thomas, according to an interview published in the New York "World" is quoted as saying the following relative to national preparedness:

> "Today a nation cannot consider itself in a state of preparedness for war unless it has planned the mobilization of its industries along the same lines as that of its army and navy.
>
> "It was all new to us and it would be equally new and equally difficult to any country who does not plan it out ahead. You have made a good start in the United States, I see, by creating a committee of distinguished scientists and inventors to aid your Secretary of the Navy."

Added to this a recent news dispatch from France demonstrates that that great nation, now at war, has seen fit to organize an Inventions Ministry, the work of which is to *mobilize scientists* who hitherto have played no part in the preparation for national defence. The scope of this Ministry will be in every way almost identical with the activities of our Naval Consulting Board.

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COAL HANDLING AT PANAMA

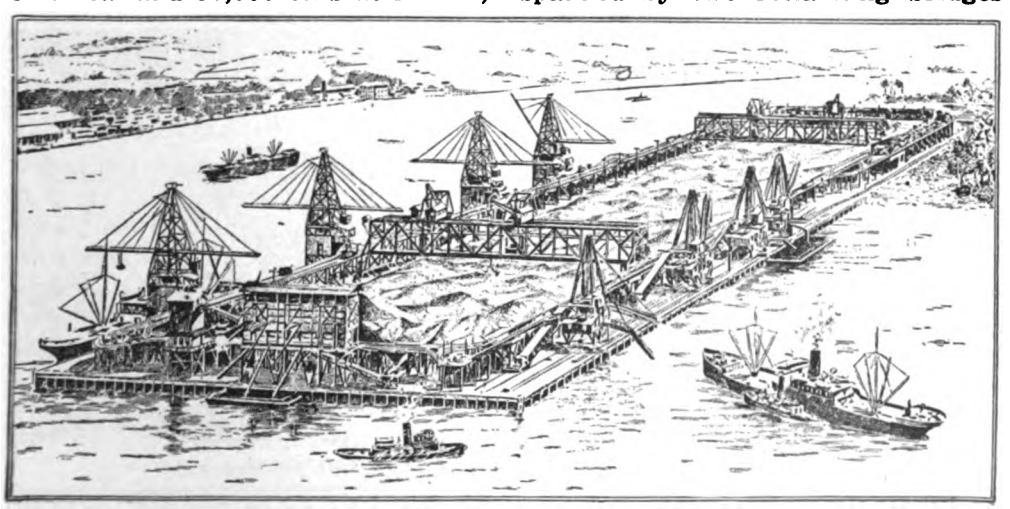
LARGE LOADING AND STORAGE PLANTS AT CRISTOBAL AND BALBOA

Coal Age

FOR military and commercial reasons it is necessary to provide large coal-handling capacity in the Canal Zone. Based on the experience of the Suez Canal, it is expected that about one million tons of coal per year will be handled. To receive this, store it until wanted and load it again on vessels, there will be a plant at Cristobal, on the Atlantic side, with a capacity of 485,000 short tons, and one at Balboa, on the Pacific side, with a capacity of 215,000 tons. These figures will probably be reduced somewhat from the necessity of storing in piles, and they include 100,000 tons of wet storage at Cristobal and 50,000 tons at Balboa, the Navy Department desiring a certain amount of coal stored under water so that it may be kept without deterioration for use in case of war.

The illustrations show the general arrangements of the plants. The Cristobal storage pile is enclosed by three large wharves, the longest being the unloader wharf, that opposite to it the reloader, and the third the end wharf. The plant has about 2,500 linear feet of berthing space with a minimum depth of 41 feet at mean sea level, the tide falling not more than one foot below this. Hence deep-draft vessels can be accommodated.

The storage space within is spanned by two reclaiming bridges



CRISTOBAL COAL PLANT AS IT WILL OPERATE

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which can move the length of the pile, about 1,000 feet. They are themselves a little over 315 feet long, are of heavy steel construction, and are supported by the wharf structures. On the upper part of each are mounted two bridge diggers, which are capable of motion along the bridges, i. e. transverse to the pile itself. Thus motion in any direction and access to any part of the pile may be had.

On the unloader wharf are four unloading towers which can travel a length of about 1,000 feet. Their function is to remove the coal from colliers and barges as it is brought in. The opposite side of the plant accommodates four reloaders and on the end wharf is a bunker holding 15,000 tons. The reloaders are for supplying large lots of coal, while the bunkers will furnish supplies in small quantity to tugs, etc., so as to avoid starting the whole plant.

Power is brought across the French Canal at 2,300 volts in submarine cables from the Cristobal substation of the Canal system. Electric power is used at 440 volts for all operations except that of the unloaders, which are run on steam.

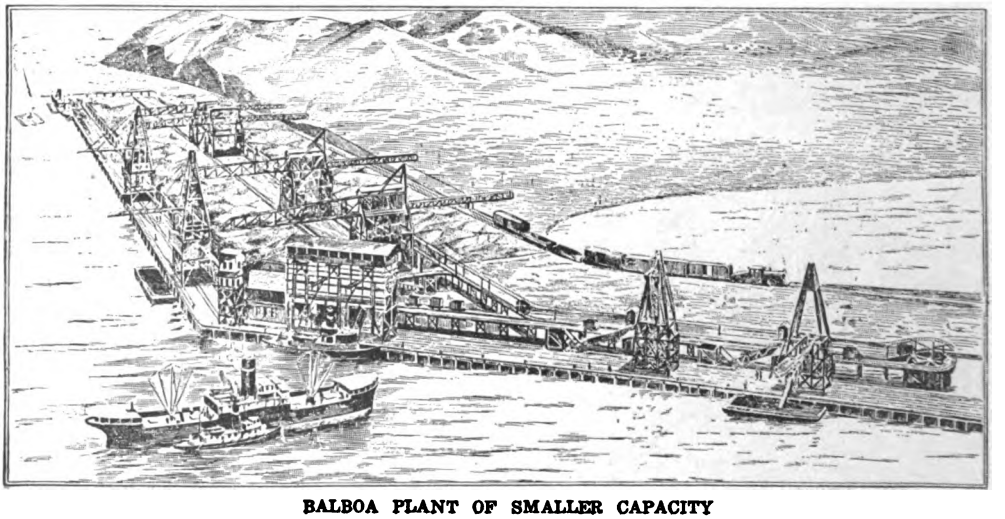
All tracks are of 5-foot gage and are connected to the Panama Railroad tracks so that coal can be transferred conveniently by rail.

The substructure consists of steel and concrete decks supported by 6-foot diameter concrete cylinders founded on solid rock. The deck framing consists of steel plate-girders and beams. The whole structure consumed about 5,000 tons of steel and 18,000 cubic yards of concrete.

The unloaders are equipped with 2½-ton buckets and have each a capacity of 250 tons per hour. Each unloader must be able to mine coal from the vessel in which it arrives and either deposit it in the tower hopper for delivery through chutes to railroad cars, or deliver it to the storage pile behind; and it must be able to transfer coal from the storage pile to the tower hopper or to a ship.

The cars receiving from the unloaders dump by means of switches and tracks at some point over the pile. They run at 200 feet per minute, hold 10 tons each and are started and stopped by a trackman.

The bridge diggers are each equipped with a 5-ton bucket and are rated each at 500 tons per hour. They can deliver to cars for transfer to various points such as the reloaders, the bunkers, etc. By means of a conveyor system supported by the



BALBOA PLANT OF SMALLER CAPACITY

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bridge, the diggers can deliver to any part of the storage pile.

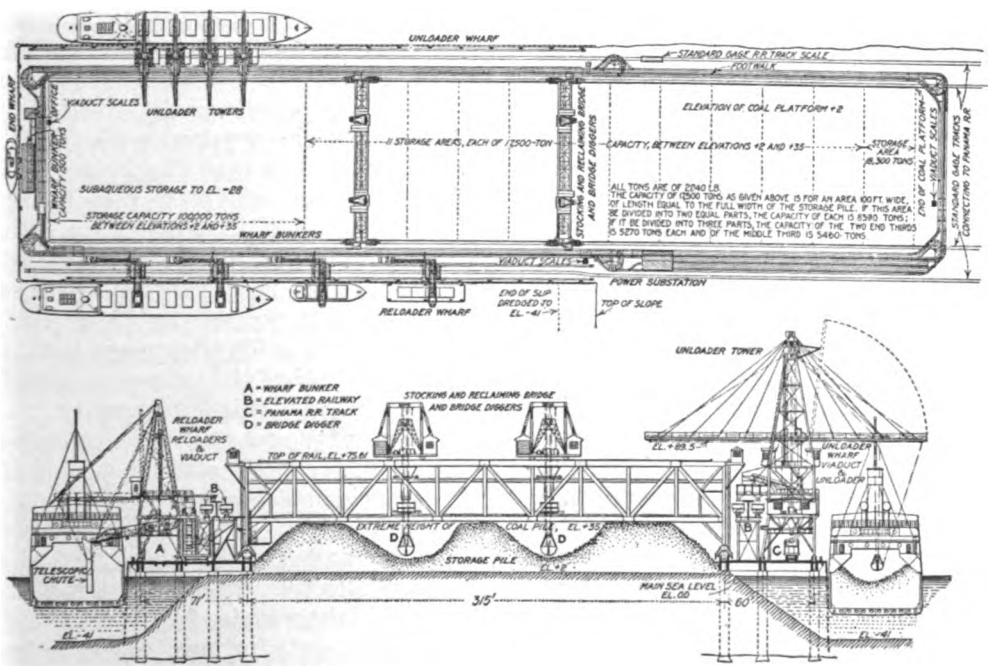
The conveyor system is elaborate. It can transfer from the unloading towers to any part of the pile, or to any reloader, or to the bunkers; and can handle incoming coal and reclaim from the pile at the same time.

The reloaders are provided with wheeled hoppers, which receive coal from cars and deliver it to inclined belts; each of these belts in turn delivers to another belt which at its outer end is connected with a hinged telescopic chute. This second belt is itself carried by a hinged swinging truss and has a considerable range of vertical motion. These inexpensive reloaders take the place of high wharf bunkers, which they equal in capacity and flexibility.

The coal is weighed by semi-automatic scales at points along the elevated railroad so disposed that every car must pass over a set of scales before reaching its destination. Similarly, standard railroad scales are provided to weigh the coal delivered direct to railroad cars.

For night work, profuse illumination is provided and while the same capacity is not expected at night as in the daytime, a complete system of signaling, communication and control is furnished in order to reduce losses to the minimum. To provide for safety to operatives, it is specified that no high-speed operation must require the simultaneous thought or action of more than one man, and protection is provided in case work should be required in the fumes from burning coal. It is also specified that the failure of any one part must not bring the plant to a standstill, by-passes, storage hoppers, parallel lines, etc., being provided in the conveyor system so as to approximate a normal rate of operation in the case of any breakdown.

The perspective view shows the main features of the Balboa plant and its differences from that described. It has only about half the capacity.



PLAN AND CROSS-SECTION OF CRISTOBAL PLANT

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NEW PROMISE FOR WIRELESS TELEPHONY

INVENTION OF PROFESSOR PUPIN TO ELIMINATE STATIC INTERFERENCE

TREMENDOUS achievements in the development of long-distance telephony have marked 1915. In the spring New York talked to San Francisco over a wire; in the fall Washington talked to Honolulu and Paris through the ether. As a climax to this came the announcement in the *New York Evening Post* that Prof. Michael I. Pupin of Columbia University had about perfected a device which would make it possible to carry on long-distance wireless speech regardless of atmospheric conditions.

Professor Pupin is very well known for his inductance coil, which made long-distance telephony possible. It is therefore fitting that he should also be the one to bring out the equivalent invention for wireless work. According to the *Post*, Professor Pupin was unwilling to go into the details of his invention but, "In a general way, he explained that the device is an improvement upon the present aerial antennae, which renders that part of the apparatus sensitive only to the electrical waves which the operator desires to receive."

"According to Professor Pupin," says the *Post*, "his invention eliminates entirely the difficulties due to what are known as static disturbances or electrical storms, which are constantly interfering with wireless messages and which render such feats as the 4,600-mile aerial conversation between Arlington, Va., and Honolulu possible only under ideal conditions."

The newly devised apparatus is in use at Columbia and has been well tried out in actual practice. By its use Professor Pupin and his assistants have picked up messages intended for other stations which were unable to read them because of unfavorable electrical conditions. Such messages were received from even so far off as Honolulu.

The sensitveness of wireless apparatus to all electrical disturbances was always its weakest point. It had never been possible so to separate natural and artificial waves that the receiver heard only what he wished to. For some time engineers worked on the theory that the forces of nature could be overcome by increasing the power of the sending apparatus. But nature's forces are so enormously powerful that they cannot be overcome. Consequently, the Columbia experiments were conducted along the lines of sifting out of the mixture of waves only those faint ripples that it was desired to receive. In order to accomplish this, electrical disturbances were made to order in the laboratory and their effect on various arrangements of antennas were studied. In the conduct of the work Professor Pupin gives great credit to Edwin Armstrong who worked with him.

It is expected that the great field of the invention will be in facilitating communication with ships at sea. The possibility of unlimited magnification of the sound received by wireless would make it feasible to install a receiver on the bridge together with a magnifier so that the officer in charge could hear every faintest message.

Professor Pupin paid tribute to the ability of Messrs. Carty and Arnold of the American Telephone, Mr. Colpitts of the Western Electric and Doctor Whitney and Mr. Langmuir of the General Electric, who, working with the great laboratories furnished them, have made contributions to science far beyond our great universities.

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Miles of Streets and Roads full of holes & ruts have been put in first class condition.

THE DEPARTMENT ADVERTISES GRAPHICALLY ITS GOOD WORK

PERTINENT PARAGRAPHS FROM A REAL REPORT

PHILADELPHIA'S PUBLIC WORKS DIRECTOR ADDRESSES THE PEOPLE

BOTH the originality and the success of Morris Llewellyn Cooke, director of public works in Philadelphia, are sufficiently known. Not the least successful and original of his methods is his manner of reporting on his stewardship to the people of the city. He believes, curiously enough, that official reports should be read, and to get them read he prepares them in the most attractive form that is reasonably possible. For pages of statistics, elaborate financial statements and bone-dry, bromidic text, he substitutes brief, clear and effective summaries of the work accomplished and vigorous arguments for further improvements and illustrates the whole with attractive photographs and cartoons. There follow some of the photographs and some of the more pungent paragraphs from the 1914 report; the latter are of interest for both their substance matter and as examples of report writing:

"There is no question affecting the administration of American municipalities today which is of greater moment than that of publicity or advertising. Speaking recently before the American Society of Mechanical Engineers, I said on this subject: 'We have got to get rid of the old-fashioned idea that advertising is a crime. I pay less attention in my reports to dignity of form and diction than to making them sufficiently interesting to be read. It is only as we engineers who are public officials learn to make the public, sometimes against its will, understand our work, that we are able to get that degree of popular support for it which will make it possible for it to be done in an efficient manner. It is true today that a man who wants to do really good and efficient work can do so only after an aroused public opinion. You cannot drive people in a democracy. The development of some varieties of municipal engineering is absolutely dependent upon the development of public opinion and must proceed with it. The matter of street cleaning is largely a question of an improved public taste in the matter of street paving. Unless

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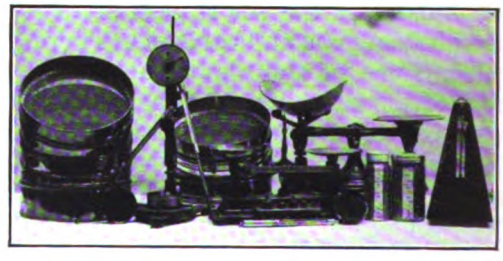
streets are well paved they cannot be well cleaned except at a prohibitive cost. To jump from one degree of cleanliness on the highways to another, without a supporting public opinion, may be enough to wreck an administration and to set the tide of civic improvement running in the opposite direction.' "

"In the matter of writing reports there is the greatest room for improvement. Too frequently in the past they have been stereotyped in form, weighted down with page after page of dry and almost meaningless figures and written in a style forbidding to all except a small professional class of municipal administrators. We have made the effort to retain in the body of our reports only such matters as are of more or less general interest and to shape them up so as to command that interest."

"Masses of figures evidently published with the idea of providing publicity really act in the contrary manner. At best the taxpayer's attention can only be attracted by the big essentials. Most municipal reports are trackless mazes of inconsequential bookkeeping entries of the old-fashioned—if not entirely obsolete—sort. Public reports should be freely illustrated with photographs and charts. We have attempted in this report to combine photographs in such a way as to utilize to the best advantage the limited amount of space at our disposal."

"Another important cause of municipal inefficiency is the military system of control which attempts to place all authority and consequently all credit for good work at the top. This constitutes a grave municipal sin, nation-wide in its field of operation. In the conduct of this department we have attempted to place the responsibility for the work of each bureau as much as possible with the bureau. The bureau chiefs have been encouraged wherever possible to use the same policy in placing the responsibility for the details of the work with the respective divisions."

"In removing garbage from the scows tied to the wharf at the reduction plant it formerly was the custom of the contractor to have men work knee deep and sometimes almost up



TWO WAYS OF TESTING ASPHALT

Old way—chewing it, sticking it up, and watching it stretch.

New way—with accurate instruments.

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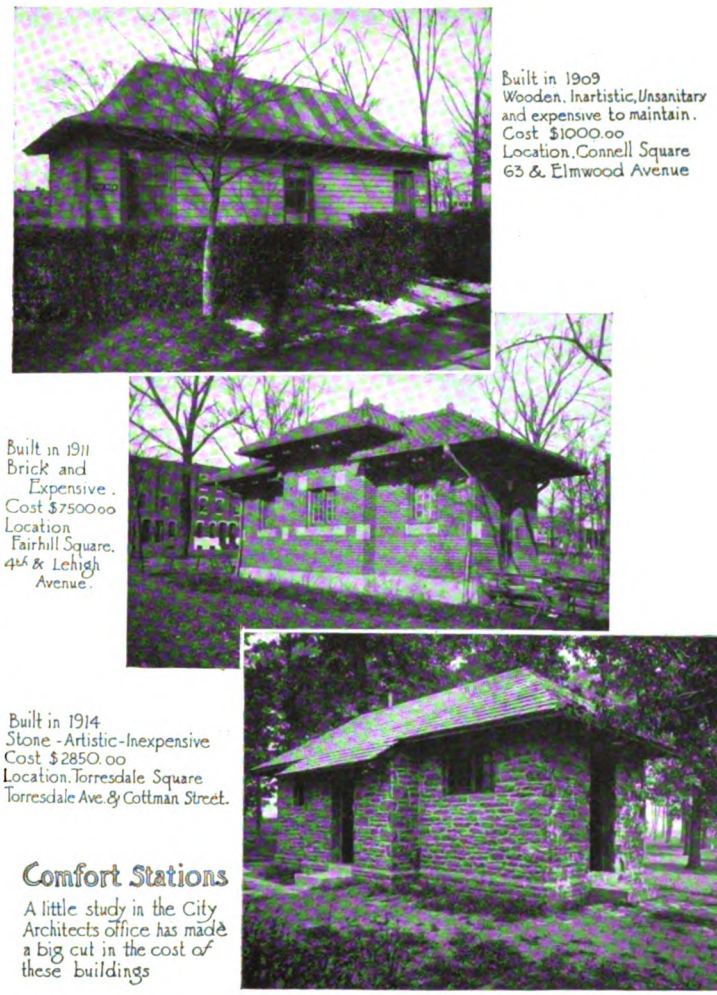
to their waists, shoveling the garbage on to the belt conveyors. Those unaccustomed to such things will find it difficult to picture this scene in its utter demoralization. I have seen with my own eyes these men lying in the putrifying garbage fast asleep—so degraded had they become by the process. It is wellnigh impossible for any industrial establishment to reach a high level of efficiency when degrading work such as this is permitted at any point. The contractor on this work—one who had grown rich and prosperous through making the city pay two prices for its garbage removal and disposal—informed us that the men engaged on this work formerly really 'liked it.' This work is now done with a clamshell scoop at a considerable saving."


Built in 1909
Wooden. Inartistic, Unsanitary and expensive to maintain.
Cost $1000.00
Location. Connell Square 63 & Elmwood Avenue
Built in 1911
Brick and Expensive.
Cost $7500.00
Location Fairhill Square. 4th & Lehigh Avenue.
Built in 1914
Stone - Artistic - Inexpensive
Cost $2850.00
Location. Torresdale Square Torresdale Ave. & Cottman Street.
Comfort Stations
A little study in the City Architects office has made a big cut in the cost of these buildings

PHOTOGRAPHIC EVIDENCE OF ECONOMY

"There is an always apparent tendency to bring to the center of the city an ever increasing proportion of the retail trade. In a city the size of Philadelphia this means putting upon the people themselves, as well as upon the streets and other transit facilities, an unnecessary burden. It has seemed to us to be good municipal policy to encourage in every way the upbuilding of separate retail centers, and more particularly those located in the outlying districts. Wherever opportunity has been offered to improve the paving, cleaning and lighting of such thoroughfares, we have embraced it. One indirect result of having even a few of the retail streets well paved, well lighted and well cleaned, will be to emphasize to our people the importance of having these civic centers and to educate the taxpayers to demand the same good conditions throughout the residential districts. In other words, we con-

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sider a few high-grade streets of this kind located in places where the people will see them the best possible advertisement of the municipal work with which this department is charged."

"The state automobile tax, even if given to the city, would be entirely inadequate to cover the damage done

Hundreds of these old fashioned hydrants are found in city squares. Only a boy knows how to drink from them. Back breakers and water wasters!
BEFORE
These modern Bubblers have been introduced. They are artistic in design, saving in water, and low enough for even the "lit'lest" girl to get a drink.
AFTER

Bubblers in our Parks

to the roads by this class of vehicle. I am quite sure that a tax fairly levied on this class of vehicle, with the assurance that the money was to be spent especially on our main traffic streets to keep them in good condition, would be almost a popular tax. Automobile owners would very soon find out that a relatively small increase in the license fee would be more than offset by a reduction in repairs. The goal toward which we should work, it seems to me, would oe to have as many of our municipal activities self-supporting as possible. In Germany this principle is followed even to the extent of making those who have fires in their home or place of business pay the full expense of putting out such fires. This puts a premium on so maintaining the premises that fires do not occur."

"An interesting example of a pick-up is shown by the reduced number of openings of the Passyunk Avenue bascule bridge. During the week April 6-12, 1913, it was opened 66 times, and in the same week April 6-11, 1914, 28 times, a reduction of approximately 58 per cent. The record for this week is practically that for the year. This was brought about by asking the Atlantic Refining Company to lower the flagstaffs on their tugboats. The difference in the number of openings about represents the traffic of the Atlantic Refining Company's fleet, when it made the trip from one part of the plant below the bridge to the storage plant above the bridge. Every trip between these points—a distance of only a few hundred feet—formerly required the opening of the bridge, simply because the flagstaffs were too high."

"The schedule of [electric] rates run from 7/10 of a cent (the rate charged the P. R. T. Co.) to 15 cents, the rate charged, for instance, for an isolated electric fan. In between these rates are others which are almost entirely without reason and with little or no reference to the actual cost. For instance, the newspapers' rate is the lowest one given, except that given to other utilities companies. Another curiously low rate of 2¾ cents is made to one company that happens to use current at a number of different points. On this theory, if a man owned a hundred houses, each requiring separate wiring, he would be entitled to a low bulk rate. There is, of course, absolutely nothing in the use of electric current to warrant any such reduction."

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"Men in the gas industry are authority for the statement that manufacturing gas costs are too high all over the country. If the value of Philadelphia's great asset, the gas works, is to be affected materially by the selling price of electricity it is necessary that the city have some one on the watch tower to safeguard its interests. It must never be forgotten for even a minute that the interests of the city and of any public utility are separate and distinct. They can never be the same. The interests of the U. G. I. Company are properly and eternally different from those of the City of Philadelphia, and the policy which not only turned over the management of the Philadelphia Gas Works to the United Gas Improvement Company, but stopped all public thinking on this subject, was as wrong as any public policy could possibly be."

"However unnecessary the boiling of water may be, it certainly can do no harm. It does seem, however, to be a great economic waste for any considerable number of our people to go to the trouble of boiling water that is as safe as the city water has proven itself to be. The purchase of spring water, however, is an entirely different matter, as the analyses which are regularly taken of spring water as sold in Philadelphia show that on the average it is ten times higher in bacteria which cause typhoid than the regular run of city water. Naturally some of these waters are better than others. Householders are reminded that city water is tested regularly through the day; first, as it leaves the river; second, as it leaves the preliminary filters; third, as it comes off the final filters; and fourth, as it comes from the faucets in the different sections of the city. This testing goes on day in and day out in a thoroughly scientific manner and can be depended upon. No matter how careful the householders who use it or the bottlers who deliver spring water, it is not possible to give spring water the same dependable oversight."

"It has appeared to me from the start that the Welsbach Street Lighting Company of America is operating in violation of the Federal laws in that it apparently absolutely controls every gas and gasoline street light in this country. Competition for this form of street lighting has so completely disappeared that it is not a proper company, it seems to me, with which a great city like Philadelphia should do business. The story of how this company has gradually 'absorbed' every interest that opposed it is in many respects a painful one. My own theory is that the Welsbach Street Lighting Company of America in building its country-wide monopoly has simply acted as agent for the great gas and electric interests of the country. These companies discovered that the gasoline street lighting business was, in a way, the key to the continuity of control of all the gas and electric interests of the country. As long as a city could buy lamp tops and gasoline, it was in a way still master of the lighting situation. Even this safeguard is gone. The gasoline lighting business is a relatively small one in itself. But the grasp of this company upon the situation is so complete that it is impossible for a prospective competitor—even if such competitor happens to be the largest city in the land—to buy for use on the street the equipment necessary to carry on any gasoline lighting, in spite of the fact that no part of the simple process is protected by patents and that similar equipment is purchased for use on farms in every part of the civilized world."

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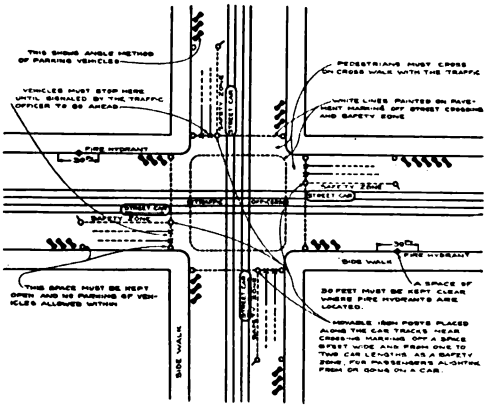
STREET SAFETY IN DETROIT

METHODS OF CONTROLLING PEDESTRIANS AND VEHICLES AT BUSY CORNERS

The Travelers Standard

A BUSY CORNER
Note outlined paths on pavement.

IN the center of Detroit a one-mile-diameter circle is subject to special traffic restrictions. Safety zones, crosswalks, parking places, etc., are painted on the pavements in white. Numerous signs are used to designate such places, usually



TYPICAL INTERSECTION OF DOUBLE-TRACKED STREETS

placed on the sidewalk near the curb, often also on round plates nearly flush with the pavement. Signs are also provided on side streets to show car-line intersections and the number of tracks.

At important crossings the width of the sidewalk is carried from curb to curb with white lines; within these lines pedestrians may cross safely so long as traffic is permitted in that direction; they are not allowed to diagonal the corner. A typical corner is shown in the photograph.

Wide streets permit of parking automobiles at an angle of 45 degrees, this saving space and allowing easier exist for an inside car. The angle of parking and the limits of the space are painted on the pavement. Automobiles make a left-hand turn by assuming a position in the middle of the street and proceeding at a signal from the traffic officer before the cross traffic starts.

The problem of boarding and leaving trolley cars is a tough one and apparently has not been entirely solved. To compel all vehicular traffic to stop behind a standing car until it proceeds, leads to congestion. In Detroit the near-side stop is universal. At the stopping point a safety zone is delimited along the track, six feet from the outer edge of the car. Within this space pedestrians are always safe but it is likely to be hazardous to approach or leave it while traffic is proceeding along that street. When traffic in that direction is stopped, pedestrians can pass freely between the safety zone and the curb, but disinclination to lose a car usually renders the passenger unwilling to wait for a halt in traffic. In streets so narrow that a vehicle cannot pass a car without encroaching on the safety zone, the vehicle must stop until the car proceeds.

The arrangements of safety areas, etc., at a corner where two double-track trolley lines intersect is shown in detail by the acccompanying drawing.

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LATHES AND PRESSES OPERATED BY WOMEN IN A BRITISH SHELL FACTORY

WOMEN MACHINISTS

SUCCESSFUL EMPLOYMENT OF ENGLISH GIRLS IN SHELL MANUFACTURE

AFTER the war a continuation of the falling off in male immigration into this country may be expected. It has accordingly been predicted authoritatively that before long we shall see women tending machine tools in American shops. What is a prophecy here has become an accomplished fact in England, where the foolishly permitted enlisting of skilled mechanics has left the munition plants in a sad way for labor. The results to date are of unusual interest and importance, indicating, as they do, a possible industrial revolution; and an article in a recent issue of *The Engineer*, describing such results, is timely.

"Some 800 girls," it is stated, "are now employed in the various shell factories organized by Sir William Beardmore. This number will shortly be very largely increased. At the works to which we are especially referring, there are at present employed over 300 girls. With the 300 girls, 60 men are employed for tool making, setting up machines, laboring and screwing up base plates, which is a matter of strength rather than skill.

"On all sides the greatest encouragement is given to work, and the greatest attention is paid to the health and comfort of the operators. Lady superintendents are in charge of the place night and day to look after the girls, a good mess room is provided for their meals, and a quarter of an hour is allowed each afternoon for tea provided by the firm. The result is an extraordinary appearance of keenness and contentment throughout the place, and whether done by day or by night the work is just as good and just as speedy."

"The girls will not admit that the work is too heavy for them, and to see them handling 4.5-inch shell bodies on the large combination lathes without using mechanical assistance or the laborers provided by the firm is a pleasure. Their health appears to be good, they are gaining in muscle and skill every week and the quality of the work they turn out is all that can be desired. So far has the output on some of the machines exceeded expectation owing to the keenness of the girls, that some of the machines provided have actually been found to be superfluous, and, indeed, the machines have been shown to be capable of more work than had ever been believed to be possible."

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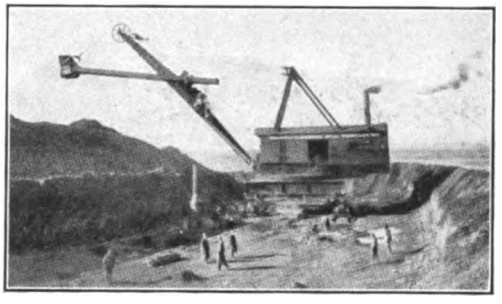
THE BIGGEST STEAM SHOVEL

EXCAVATOR BUILT FOR STRIPPING COAL BEDS WEIGHS 310 TONS

Engineering



INDUSTRIAL DREADNOUGHT AT WORK

THERE has been built for the Carney-Cherokee Coal Company of Mulberry, Kansas, what is claimed to be the largest steam shovel in the world. Its weight is 310 tons and its excavating capacity is given at 5800 cubic yards of material in eight hours. The exploitation of the shallow flat-lying coal seams of Kansas and other Mid-Western states which involves stripping off the overburden, has been attempted by various excavating methods, but practice has latterly converged on the heavy, double-track steam shovel with large dipper and long boom. The largest of these yet built is that shown herewith, made by the Bucyrus Company.

The shovel comprises an underframe provided with four 4-wheeled trucks. This underframe carries a revolving platform on a circular track; the boiler, the engines and the boom are mounted on the revolving platform. Hoisting the dipper, swinging the platform and running the dipper-arm in and out are performed by different engines. The main hoisting engine is used for propelling the complete machine.

The boom is of structural steel of box-girder construction. The dipper is hoisted by a single rope over a large sheave. The main revolving platform is constructed of four main longitudinal steel members connected by transverse girders and separators. The heavy stresses at the front of the structure are taken care of by a large steel-casting separator and heavy box-girder construction. Another steel casting at the middle, centers the platform on the underframe. The platform is kept as small as possible in order to facilitate work in a narrow cut. It is 47 feet 7 inches over all.

The platform rotates on a turntable consisting of 60 steel rollers revolving between circular members built up of 90-pound rails. Of the four trucks, two are attached direct to the underframe and the other two through an equalizing beam and a pin, thus obtaining a three-point support. When digging, however, the beam is arranged to support the frame at its ends by the insertion of jacks. Propelling is accomplished by driving on all four trucks, using a chain-drive from a central vertical shaft geared to the hoist.

The main hoist has two 13 by 16-inch cylinders and a 48-inch drum. An auxiliary drum is provided for handling the end of the boom by means of suitable blocks and rope. The swinging engine rests on the front of the platform and drives through a vertical shaft and toothed gearing. It has 10 by 10-inch cylinders. The dipper engine is mounted on the boom and has also 10 by 10-

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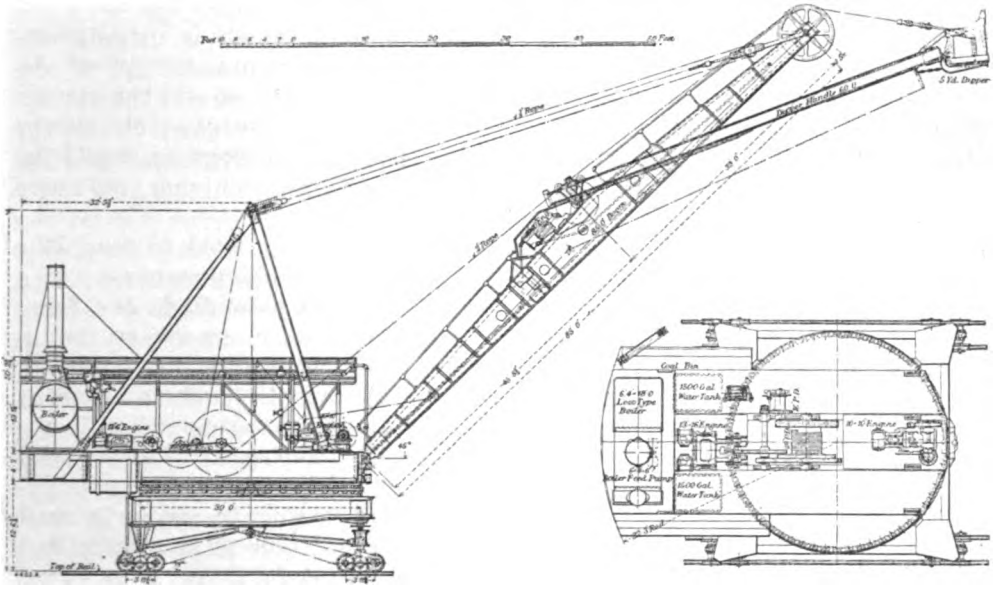
inch cylinders. Practically all the machinery is mounted on structural-steel bases permitting it to be shipped as units and readily erected. The boiler is of the locomotive type, designed to operate at 150 pounds. Two 1500-gallon water tanks are hung below the revolving platform.

quently a long boom and dipper-handle. The shovel in the photograph has a 75-foot boom with a 6-cubic yard dipper. The drawing shows an 85-foot boom with a 5-cubic yard dipper and with this a reach of 100 feet can be had. The shovel thus equipped can dump 68 feet above rail



ELEVATION AND PLAN OF BUCYRUS GIANT STEAM SHOVEL

In stripping a coal bed with a shovel of this type, the first operation is to take out an initial cut the length or width of the area to be opened. The spoil from this first cut is thrown to the side where it is least likely to cause trouble in future operations. The coal-mining operations follow pretty close behind the stripping shovel. When the end of the cut is reached, the stripping shovel is turned around and started back, making a parallel and adjacent cut on the side to which the initial spoil was not thrown. The spoil from this second cut can be thrown into the first excavation, from which the coal has been removed. This process is kept up until the coal is extracted.

It is evident that this scheme of operation requires a very wide and high reach in the shovel and consequently a long boom and dipper-handle. The shovel in the photograph has a 75-foot boom with a 6-cubic yard dipper. The drawing shows an 85-foot boom with a 5-cubic yard dipper and with this a reach of 100 feet can be had. The shovel thus equipped can dump 68 feet above rail level, can make a cut of 106 feet radius at 40 feet above the rail and one of 76 feet radius at the bottom of the pit. With the 75-foot boom, the maximum dumping height is 62 feet at a radius of 91 feet.

Its speed of operation is remarkable in view of its size and weight. Over a week's run the shovel averaged 645 cubic yards per hour, equivalent to an average of one and three-quarter swings per minute, and in one day it excavated 5,860 cubic yards in 8 hours and 4 minutes from a bank varying from 17 to 20 feet high.

An unusual feature of the machine is that it can be converted with little trouble into a drag-line excavator, such as is used for excavating canals and for stripping shallow deposits. Thus converted it would carry a 175-foot boom and an 8-yard bucket.

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INDIRECT FIRE

ITS OBJECT, DIFFICULTIES AND METHODS OF CONTROL

E. Vallier—Revue générale des Sciences

CERTAINLY one of the surprises of the present war is the great development of indirect fire, a method of fire usually reserved for siege warfare. Indirect fire is made use of to reach an object concealed by some interposed or some superposed mass. Such fire is also called plunging fire and involves a relatively high angle of fall for the projectile, 20 to 30 degrees according to the distance to be covered. It may happen that for a given distance to the target the required plunging fire will necessitate an angle of discharge which would carry the projectile too far and its initial velocity must be reduced by reducing the charge of powder.

The powder charge for indirect fire is usually less than that for direct firing; with true siege pieces, the charge can be varied at will but with field pieces there are usually available only two or three sizes of charges prepared in advance, which restricts the field of possible combinations. The maximum charge may be used and a position taken at considerable distance from the mark, but this makes direct observation difficult and decreases the accuracy of the shooting.

Indirect fire approaches vertical fire when the mark presents a surface almost horizontal, and has a small vertical dimension, as in the case of a concealed battery. Formerly 45 degrees was almost always used but today cannon and rifled mortars are made so accurate that the angle can be varied as closely as in direct firing. An angle of 45 degrees gives the maximum range, and one of 60, the maximum practicable angle of fall. Between these extremes lies the angle of 55 degrees which is usually employed with advantage. At 60 degrees accuracy is lost and the projectiles do not fall successively in the same spot. At 30 degrees, while the accuracy attained is higher, the angle of fall is too flat.

Plunging fire is used to reach the enemy behind embankments or in a depression and to enfilade the faces of a permanent or temporary fortification; vertical fire is used against horizontal targets such as vaults, powder magaines, protected railways or sunken batteries; it is also useful to tear up supporting walls; a melinite shell exploding in an earth wall will tear out a hole as if a mine had exploded. In coast defence, this kind of fire is useful for piercing armored decks, so as to reach the boilers, engines or magazines of the ship. The explanation of the fact that indirect fire, an accompaniment of siege warfare, is being used today, is that this war is practically one vast, extended siege.

During the first weeks of the war, batteries of various calibres, taking advantage of their great range could hide behind hills or trees or even dig themselves in like siege guns and direct their fire from under such cover. But the introduction of aerial scouts made some sort of concealment necessary. Thus the Germans on the Aisne used quarries, and coverings of thatch and branches were also utilized, firing being suspended when an aviator was seen in the vicinity.

The mere ballistic problem of indirect fire is complicated by the diffi-

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culty of ascertaining the location of the mark which it is desired to hit, if this be for instance a concealed battery. Acoustic methods are principally made use of in locating such a mark, based on the velocity of sound. Knowing the elapsed time between the discharge of a cannon and the arrival of the sound of its discharge, its distance can be easily estimated. If a second observer at an appropriate distance gets the times for the same shot, the distance from him can also be calculated and the cannon must be at the point of intersection of two circles drawn with the two observers as centers and the two distances corresponding to each as radii. It may be that the discharge of the cannon cannot be observed. In such case it can be located only upon a line, which will be a hyperbola having the positions of the two observers as foci and for a major axis the distance corresponding to the difference in the times at which the report was heard at the two positions. Now if a third observer be employed, two more hyperbolas can be constructed in the same manner and the cannon will be located at the intersection of these.

The theoretical solution as outlined is easy, the practice of the method in actual warfare is a different matter. The observers will probably use registering instruments and these unfortunately cannot distinguish between the cannon sound and other sounds in the vicinity of sufficient intensity to actuate the mechanisms. Hence there is bound to result a great deal of confusion and only by complicated processes can a solution be arrived at. Another difficulty lies in the fact that almost every discharge of a cannon results in two sounds, both of which are recorded by the microphones used.

When a projectile penetrates the air with a speed greater than the velocity of sound, it compresses the air immediately in front of it and forms what may be termed a stationary wave; this is a single wave without any periodic variation of compression to an observer who might be proceeding with the speed of the wave. When this wave reaches the ear it affects the latter like a single, sudden, sharp sound. It may be conceived of as the same wave which would be formed if the projectile were stationary and the air moving past it. It is known as the Mach wave, from Professor Mach of Prague, who first offered the explanation of its nature now generally accepted. It is not to be confounded with certain whistling sounds caused by the rotation of the projectile or by other means.

After the Mach wave has been heard by an observer in the vicinity, there follows a moment of intense silence and then comes the dull report of the exploding charge in the gun. It is clear that the occurrence of these two sounds emanating from the same shot would cause confusion in the reading of any automatic recording device and would also mislead any observer not well acquainted with the phenomenon. It should be noted, however, that the Mach wave is audible only when the projectile moves with a velocity greater than that of sound.

One other method for locating a battery is a recalculation from observations on the projectile itself. If one can ascertain the ballistic properties of the projectile, that is its weight, its dimensions, and what is called its ballistic coefficient, and can also observe the angle of fall or some other element of its trajectory, it is possible to calculate the distance and direction traversed and thus locate the gun. The actual procedure is too complicated for exposition here.

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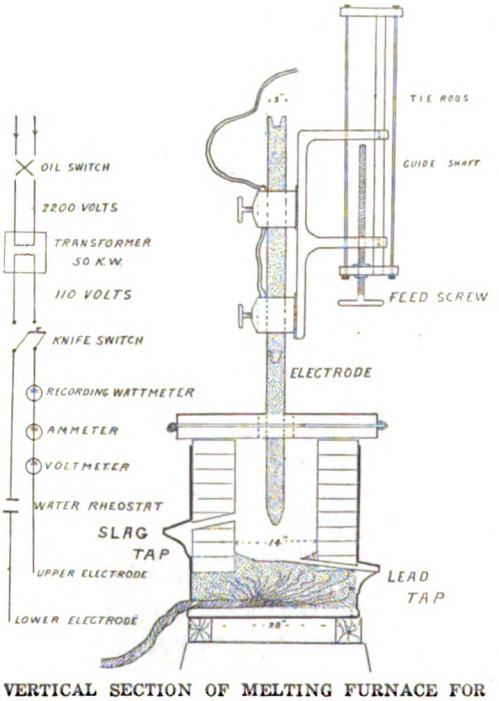
Electric Furnace for Gold Refining

Ingenious Device for Working Up Cyanide Process Byproducts

W. P. Lass—Bulletin, American Institute of Mining Engineers

At the Alaska Treadwell mine near Juneau, Alaska, part of the gold is recovered by the cyanide process. The gold precipitated by zinc in this process is refined by the lead-melting method and the byproducts from this refining, together with other miscellaneous gold-bearing material from about the plant, require another treatment to extract the gold. This re-treatment was formerly a smelting in a small blast furnace. Difficulty was had with this in several ways and an electric furnace was therefore designed and built.



VERTICAL SECTION OF MELTING FURNACE FOR CYANIDE REFINERY SCRAP

The illustration shows the general features of this furnace; it was constructed from an old steel acid drum. The drum bottom was cut off, a cable of strands of copper wire introduced in the bottom and the strands spread out. Powdered graphite mixed with 10 per cent of cement was tamped wet over the wires, thus forming the bottom electrode. The inside of the furnace was lined with firebrick, giving a melting chamber 14 inches in diameter by 20 inches high. The upper electrode is a carbon or graphite rod 3 by 40 inches, in sections to permit continuous feeding and prevent loss of stumps. This is raised and lowered by a screw. The charge is introduced through an opening around the electrode and another opening takes care of the gases.

The furnace is operated on one phase of a 110-volt lighting circuit. Voltage at starting and while running is regulated through a water rheostat. At starting the furnace is operated as an arc furnace, charge being fed in slowly. When the charge is complete and melting, the upper electrode is a foot or so below the top of the melt and the furnace is operating as a resistance furnace.

A typical charge weighs about 160 pounds, made up of 100 parts of byproducts from the precipitate refining, twenty of old furnace linings carrying 60 per cent of CaO, 20 of litharge, 2 of coke and 3 of scrap iron. This is melted in about 2 hours and 10 minutes, and is allowed to settle for 15 minutes before tapping.

The furnace saves loss of gold in flue dust and in slag, gives a nicer regulation of melting temperature and is less injurious to the health of the operators.

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IRRIGATION PROJECTS IN RUSSIA

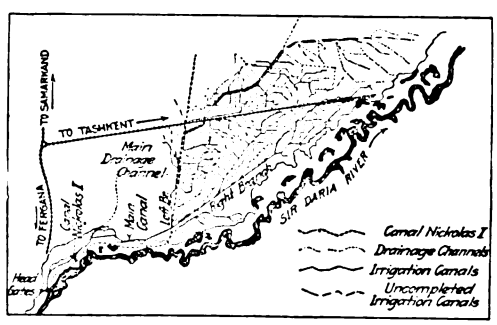
TWO LARGE UNDERTAKINGS WILL RECLAIM EXTENSIVE AREAS

Milan Nikolitch—Engineering News

EXCEPT for small-scale, rough native works, irrigating is a new art in Russia. The systematic work of the Russian reclamation service was begun only a few years ago and there is no important private enterprise in the country. Two projects now partly completed are in the nature of pioneer work and do not represent the standard practice of the service, but they are of interest as being of some magnitude and as indicating the field of development which is available. One of these is situated in Turkestan, the other in Caucasia. Both of these regions are below the average for the Russian Empire in annual precipitation. They contain large areas of arid lands of which only a small part is now irrigated, although many million acres would be available for cultivation if suitable works were constructed. Probably in ancient times a certain portion of the desert land in these regions was irrigated, but it is impossible to judge how extensive these old works were. While a number of rivers rise in the mountains and traverse the plains and these are capable of irrigating a large part of the desert land, they are not sufficient for all of it.

The undertaking in Turkestan is called the Golodnaya Steppe project. This Steppe region lies between the Sir-Daria River, the Turkestan Mountains and the Kizil Kum Desert. It lies about 900 feet above sea level and comprises, all told, about 2,000,000 acres, not all of it irrigable, however. About 220,000 acres will be reclaimed by the first project and large additional areas by other undertakings. Favorable markets, railroad communication, rich soil and a good climate indicate success for the work.

The country is extremely hot in summer and very cold in winter. The light average precipitation, about twelve inches, occurs mostly in the winter. The air is dry and the hot summer soon burns up the luxuriant vegetation of May. The irrigating water is to be diverted from the Sir-Daria River, formed by two torrential streams in the mountains of the central Tian-shan, and flowing eventually through the central Asiatic plain to the Aral Sea. The water is supplied from the melting of mountain snows and the period of high water fortunately coincides with the hot, dry, summer months.



GOLODNAYA STEPPE PROJECT

The fact that the river lies 50 feet below the floor of the Steppe made it difficult for the ancients to utilize the water for irrigating, only the low lands along the river and the country adjacent to the cañon mouths being available. Several Russian attempts were made to use the water, but only one project, the Canal Emperor Nicholas I was successful; this serves

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about 32,400 acres. The large Golodnaya project was taken vigorously in hand for the first time in 1911 and work completed by 1913 supplied 121,500 acres.

The project comprises the headworks, the main canal 23.6 miles long, the distributaries and main drainage canals 110 miles long, laterals and secondary drainage channels about 870 miles long, and regulators, bridges, outlets, etc., 540 structures in all. There is no dam at the headworks, the sill of the entrance being built about flush with the bottom of the river. The headgates consist of a series of openings separated by masonry piers and fitted with steel gates. Stop logs divert the debris which travels along the bottom.

The main canal ranges in width at the bottom from 56.7 to 98 feet and in depth from 5.25 to 9.45 feet, with a grade of from 0.0001 to 0.0007. Its discharging capacity is 1715 second-feet. The total earthwork, done mostly by hand, was 8,130,000 cubic yards. This main canal branches into two, of which the left is not yet completed. The right has a capacity of 600 second-feet the left, 1294, the respective lengths being 29.3 and 33.3 miles. Most of the water in these canals is above the surface of the adjacent land; a large part of the excavation went into embankments, which are 10.5 to 17.5 feet wide. The earth was packed with special care in the embankments, being water-settled in basins in many cases. The grades vary from 0.0001 to 0.0005. The lateral distribution thus far has been built for units of 370 acres, but since the land is sold in units of 21.6 to 27 acres, the distributing system will probably be brought to conform.

The country served has a slight slope and the proximity of ground water, the presence of alkali and the probable increase in this from irrigation, made a system of drainage in connection with the irrigation a necessity. The main drainage canal lies between the two branch irrigating canals. It is about 36 miles long and discharges 515 second-feet.

The permanent bridges, regulators and outlets were built of concrete, the substructures under railroad tracks of concrete and rubble masonry, temporary bridges of wood, and buildings of brick and adobe.

The completion of other neighboring projects will bring about 1,323,000 acres under cultivation in this part of Turkestan. For these larger undertakings, however, more elaborate headworks will be required, probably involving a dam across the Sir-Daria, which will furnish a certain amount of hydro-electric power.

The Mugan Steppe irrigating project is situated in the southeastern part of Caucasia. Two main rivers, the Kura and the Arrax, discharge into the Caspian Sea. The Mugan Steppe occupies the eastern part of the valleys of these rivers and forms a square between them, the Persian boundary, and the Caspian. Probably most of it was formerly covered by the waters of the Caspian and it is, in fact, situated below the level of the Black Sea. The two rivers emptying into the old sea formed the Steppe in a fashion similar to that in which the Colorado formed the Imperial Valley and the whole relation of river and land is a close parallel to that existing in Southern California. The rivers carry large quantities of suspended matter, which is either deposited at the point of discharge or spread over the country at the time of high water. The Arrax has overflowed, changed its course, formed lakes and deposited new layers of silt several times in the recent history of the region.

The irrigation project is to obtain its water from the Arrax. This river

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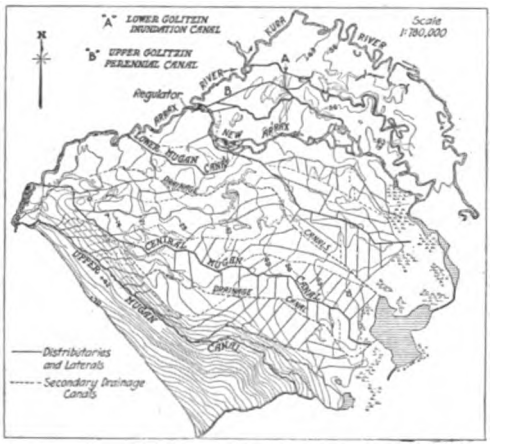
rises in the mountains of Turkish Armenia not far from the sources of the Euphrates, and flows east into the Kura, which flows to the Caspian. Unlike the relation existing in Turkestan, the low-water period of the Arrax corresponds to the period of least precipitation, that of July and August. The large quantity of silt which the river transports, about 1.12 per cent by weight in the spring floods, is beneficial to the soil and can be used as a fertilizer, but a large content of dissolved salts is also present.

Much of the Mugan was irrigated in ancient days and for 15 years the northern part has been irrigated by Russians, who built flood canals. The perennial canals date from 1908. The total irrigated area is now 465,000 acres, lying between the two rivers, the upper Mugan canal, and the Caspian swamps. The recent and important works are in the region south of the New Arrax River. There are four independent systems involved, one completed and three nearing completion.

There are five sets of headworks in all, of rather simple type. They consist of masonry or concrete floors with structural-steel bents erected on them to carry the gates. Three main canals run out from the Arrax parallel with one another. The total length of main canals in the southern Mugan is 133 miles. The laterals and distributaries are 1470 miles in length and laterals often take out of the main canals. It has been found that one good irrigation in the spring is sufficient to insure a crop.

The land being subject to overflow and protected by levees needs thorough drainage in order that the alkali problem may not become threatening. The complete drainage system indicated on the map comprises main canals between the main irrigating canals, which discharge into the lakes and swamps along the Caspian.

River control is a serious problem. The Arrax at the time of its last bad break in 1896 formed the New Arrax and left 13 miles of the old bed dry. This break was closed in 1908 by the Regulator Nicholas II which has been successful both in closing the break and in relieving the pressure on the old channel at flood time. The river embankments made of soft silt are easily eroded and hence the headgates have been placed far back from the river and protecting spurs built to divert the river current.



MUGAN STEPPE PROJECT

The spurs are built of concrete or masonry in cubes 3½ feet on the edge, these being lowered into position from boats. The river bottom is soft and the spurs sink into it to a considerable depth. Generally speaking the construction of spurs is expensive and their ultimate value is not yet proved.

The Milsk Steppe irrigation project soon to be commenced on the left bank of the Arrax will reclaim 405,000 acres. For this supply and that just described the river will be inadequate unless additional storage is provided. Storage reservoirs and the supply of main canals are the chief problems on the Arrax.

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LOCOMOTIVE IMPROVEMENTS

SUPERHEATERS, STOKERS AND OTHER DEVICES INCREASE CAPACITY

The Traveling Engineers' Association

A COMMITTEE, appointed to consider the subject of modern appliances on large locomotives, such as superheaters, brick arches, pyrometers, mechanical stokers, drifting valves and flange oilers, reported favorably on their advantages.

The superheater is now almost an essential part of the large locomotive and its success is largely responsible for the development of the large engines of these days, while its installation even on small locomotives increases capacity from 25 to 30 per cent. The superheater under operating conditions saves 20 per cent of the fuel burned and from 25 to 30 per cent of that burned while the locomotive is working steam. It effects a reduction of 30 to 35 per cent in water consumption, an important factor where water is expensive, and is furthermore important in reducing the number of water tanks and of train stops. Boiler capacity is increased by the reduction in the quantity of steam needed per unit of horsepower. The increase in boiler capacity increases again the hauling capacity of the locomotive. This means longer trains and faster schedules with the attending obvious advantages. Cylinder condensation is eliminated and the boilers can be operated at lower pressures, thus prolonging their life. Outside steam pipes may be used with superheated steam, which improves the draft in several ways.

It is to be noted that the improvements following the use of the superheater have been made in the face of the fact that it has been applied to boilers not especially designed for it; the installation of the superheater reduces the heating surface of the boiler and it absorbs heat which before went to the boiler. With boiler design changed to meet the new conditions, and with the use of higher degrees of superheat, the future should see still greater successes.

Lubrication of valves and cylinders on superheater locomotives requires the use of a high-grade, "superheater" oil, one having a high flash point, and care must be exercised in the installation and maintenance of the feeding pipes and accessories.

In connection with superheaters, the pyrometer is becoming increasingly common for showing the degrees of superheat. The electric pyrometer, used to indicate the temperature of the steam in the steam chest, is sensitive and dependable; it assists the engineer to obtain the maximum efficiency from the superheater.

The use of mechanical grate-shakers presents advantages in the case of large engines. They are arranged so that any section of grates or combination of sections can be shaken or dumped simultaneously or separately, they allow the grates, furthermore, to be operated by hand when desired. They are of assistance to the fireman in keeping his fire clean and in getting sufficient air through and also save time and labor in dumping and cleaning at the ashpit.

Valves arranged to pass live steam to the cylinders while drifting are desirable. They tend to prevent oil carbonization, and, by eliminating pounding when passing over centers, reduce wear and maintenance cost.

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The ideal valve should open automatically when the throttle is closed and the engine drifting and close automatically when the engine stops; without the latter characteristic it would be dangerous. While several drifting valves are obtainable, none of them meets the conditions set up. The use of the throttle to admit steam while drifting is recommended. Valve feed of oil is in general preferable to cylinder feed.

The brick arch has developed from a fuel saver to a capacity increaser. It increases capacity directly by aiding combustion and reducing heat losses. This, of course, increases efficiency. The arch tubes supporting the brick add heating surface; the arch forms a combustion chamber where the gases are mixed; it holds back coal dust till it can burn; it makes the flame sweep the back of the fire box and increases the efficiency of this evaporating surface; it increases and holds more constant the firebox temperature, thus increasing evaporation and protecting the flues. The efficiency of the arch increases as the rate of combustion increases. The arch reduces smoke formation by 50 per cent, sufficient to permit operation within the law in many restricted localities. Finally, the arch is an important factor in reducing flue failures due to plugging and honeycombing. Reductions in flue work up to 45 per cent are reported.

The flange oiler is a device which delivers a jet of asphaltum oil against the flanges of the drivers. Its chief function is to save wear on the flanges when passing over curves. This is particularly important because the turning of a new flange means the removal of a large amount of metal from the tread of the wheel, and a considerable cost in labor and material. With the use of oilers tire flanges will wear from two to four times as long. The oiler effects a further economy in rail wear, and it is a safety device in that it tends to prevent the flange from climbing the rail on curves and causing derailments.

It is important that a flange oiler be operated with a heavy asphaltum oil. It is impossible to get results with any other kind of crude oil, since the lubricant will run down between the tread and the rail and cause slippage. The oiler requires intelligent installation and operation. The pipes must be firmly clamped and the nozzles properly placed. It requires little attention but is not foolproof.

Mechanical stokers have many advantages. Primarily they make it possible to work a heavy freight locomotive to its full capacity. A lighter fire is possible which gives more perfect combustion and responds more rapidly to changes in demand. A more uniform firebox temperature eliminates expansion strains and reduces repairs. The light fire can be more rapidly cleaned. Less smoke is made and it is less variable.

The stoker makes it possible to burn poorer fuel and save money because of the lower price, although more is consumed. This also gives a chance to screen run-of-mine coal and save the clean product for hand firing. The elimination of the arduous hand firing makes it easier for the fireman to study the handling of the locomotive. The development of the stoker has made possible the building of Mallett and other large locomotives which could never have been fired by hand.

It is admitted that the stokers sometimes give trouble in wet and freezing weather, and that a stoker failure usually means an engine failure, due to the light fire carried. As to the cost of maintenance and the preference of engineers for hand or stoker firing, opinions vary. Overfed stokers seem more generally used than underfed.

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LIGHTNING PROTECTION

EXPLANATION OF STROKES AND MEANS OF PREVENTION

George H. Armstrong—Electrical World

THERE is no longer any question as to the effectiveness of proper lightning-rod protection. It performs two functions: First, it prevents lightning strokes by permitting an accumulated earth charge to leak off slowly and harmlessly through the points; second, when a stroke does occur, the rod protection conducts it to earth without injury to the building.

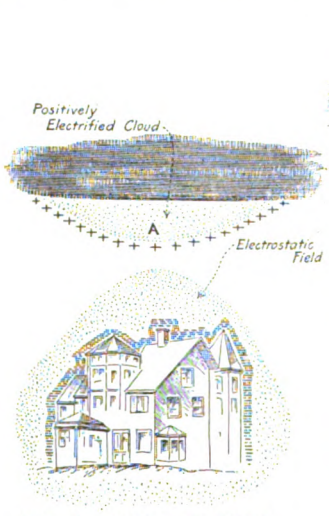

FIG. 1. INDUCED FIELD

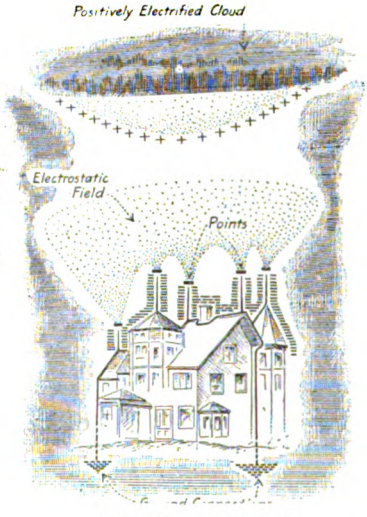

FIG. 2. LEAKAGE

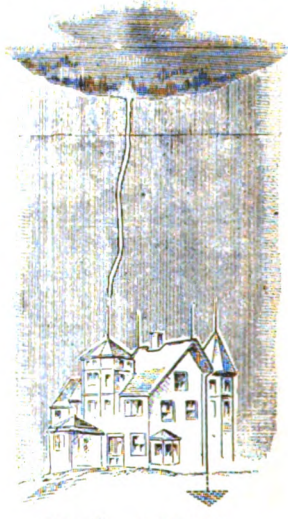

FIG. 3. A FLASH

No great amount of energy is involved in a lightning discharge, only about seven million foot-pounds, in spite of the tremendous difference of potential, namely, fifty million volts; but it takes place in so short a time, one-twenty-thousandth of a second, that its effect is highly concentrated and capable of inflicting serious damage. This damage may be either the result of intense heat which melts metal encountered in the path of the discharge, or it may be disruptive, as when a tree is split. Certain objects, those consisting largely of grounded metal, appear immune. Such are railroad trains, buildings having metallic grounded sides and roof or consisting wholly of metal frames, grounded steel windmill towers, battleships, and business blocks. In these cases there is sufficient metal to permit a great deal of leakage and to take care of any discharge. Wooden buildings, stock, trees and stacks are peculiarly liable to injury by lightning.

Figure 1 shows how an electric charge is induced and attracted to a house under an electrified cloud. The system is identical with that in a charged electrical condenser. If the building is equipped with rods and points, the induced charge will flow from the latter so fast as to lower the potential between the electrostatic field about the house and that of the cloud, before a breakdown of the air and a discharge can take place. This process is illustrated in Figure 2. If the flow or leakage is too slow, the po-

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tential difference builds up and overcomes the resistance of the intervening atmosphere and a lightning stroke takes place. This is illustrated in Figure 3. A difficult condition to combat is shown in Figure 4. With clouds *A* and *D* near each other, *D* may discharge to earth, making the stroke *C;* this forces a discharge between *A* and *D,* which builds up the potential of *A* to such a point that the flash *B* to the building takes place.

metallic members of the house should be connected to the rod system and in such a manner that accumulated charges can flow to the conductors and be dissipated. This requires that the connections be at the high points of such members, in the attic for instance, since the charges will be attracted to the high points by the field of the cloud. These members should also be connected to the rod system wherever they approach within 6

FIG. 4. CUMULATIVE DISCHARGE

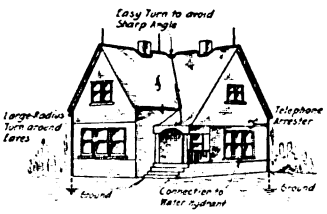

FIG. 5. HOUSE PROTECTION

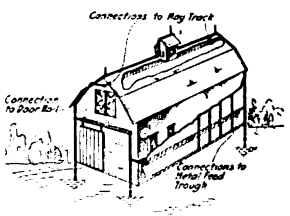

FIG. 6. BARN PROTECTION

Copper is the best material for rods, since it will not corrode. Iron is satisfactory if it is of sufficient section and is not permitted to rust away. Aluminum is also available. Contacts of dissimilar metals should be avoided, as they may form a couple and corrode through electrolytic action. It is important to have sufficient weight of metal per linear foot. The rod should be fastened to the building by metallic connections to conduct off any collected charge.

Figures 4, 5 and 6 show outlines for properly installing rods. A satisfactory arrangement is to ground the conductor at one corner of the building and run it across to the diagonally opposite corner, dividing the roof and building into two parts as nearly equal as possible; the wires to additional grounds should divide the main conductor into equal sections as closely as convenient; conductors should be carried down corners not sides.

Efficient grounding is essential. There should be intimate contact with the earth over a considerable area of the conductor and if possible the contact should be moist. All

feet; otherwise side flashes may occur. Among such metallic members are the piping systems, metal drinking troughs, barn-door rails and metal hay racks.

Telephone wires should be protected. The arresters furnished by telephone companies are too frail and sturdier devices should be applied. Ungrounded wire fences are a source of danger to stock and to buildings. Animals crowd against the fences in a storm and the wires may conduct a discharge to them which will be diverted to earth through their bodies. Such a discharge may also be carried into a building and cause a fire. Fences should therefore be grounded at frequent intervals.

The discharging points of the rod system are as effective when short as when long. They are perhaps best of copper tubes terminating in points, but with iron rods should be of pointed iron. Glass balls, weather vanes, etc., are purely for ornament or for some purpose unconnected with lightning protection and have no function in the electrical operation of the device.

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Drainage of Irrigated Lands

WATERLOGGED SUBSOIL IMPAIRS IRRIGIBILITY OF TOPSOIL THROUGH SATURATION AND ALKALI ACCUMULATIONS

D. W. Murphy—Engineering Record

IT is frequently asked why it is necessary to drain lands to which irrigating water is supplied; it would appear that water should be applied artificially only in such quantity as may be needed for the growing crops. Ideal practice would indeed involve this balance between supply and consumption but this can be attained only by long experience in the art. At present the need of drainage for irrigated lands is increasing rather than decreasing and this in spite of improved irrrigating methods.

In the practice of irrigating, water is supplied to the surface of the ground from distributing canals in varying amounts depending on the topography, the character of the soil and the irrigator. Part of the water is lost from the canals and laterals by seepage; part of that delivered is wasted from the surface and absorbed by land which does not need it; part is lost underground because it is applied too rapidly for the surface soils to retain it. Consequently the subsoil receives water and gradually becomes filled if the excess is not removed. In many cases a porous subsoil will carry away the excess itself, especially on small areas; there is always a water movement by percolation through the subsoil. But a less pervious subsoil, particularly when underlying a large area, tends to fill up and raise the water table to the surface of the ground.

Of the sources of this excess water, the seepages from canals can be stopped only through lining, which is in many cases too expensive to consider, while the excess applications are difficult to control owing to the varying requirements of different crops and localities and the lack of data. Economic irrigation, the application of just enough water to the soil, requires careful land preparation and skill on the part of the irrigator. The difficulty of control is enhanced by the existence of ground water even in arid regions, which at certain points will extend to the surface or near it.

Examples have been found where the water table has been raised 50 to 100 feet following irrigation, because the natural drainage was unable to carry off the seepages and excess waters. The fact that the underground waters must usually travel farther on large areas than on small renders the former especially liable to waterlogging. The two effects of this raising of the water table are to render the soil unfit for raising crops because its interstices are filled with water, and to deposit alkali on the surface through capillary action and evaporation. The alkali salts thus concentrated are many of them harmful to plant growth. For proper cultivation, the water table must be kept below the zone of plant growth; and to prevent the concentration of alkali it must be kept low enough so that capillary action cannot bring water to the surface where it may evaporate; artificial drainage is frequently necessary to effect this control.

Ground water is constantly in motion, the rate and direction of its mi-

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gration being controlled by the topography and the character of the material traversed, particularly the relations between porous and impervious areas and layers. Such water at certain points tends to come to the surface as seepages. Drainage works should be so constructed and located as to skim off the top of the water where there is a tendency for it to reach the surface.

Drainage works are of two classes, intercepting drains and relief drains. The first catch and divert waters before they reach lower areas which they might injure; the second tap underground reservoirs in porous materials and effect a general lowering of the water table.

The ground water is prone to come to the surface at the foot of slopes, which are therefore natural locations for intercepting drains. But even here it is frequently in a porous layer too deep to be reached easily. It is also frequently difficult to drain flat areas of their ground water by drains in them, since it is at depths too deep to tap. In such cases the water in the lower subsoil is frequently under pressure which forces it through the topsoil. Relief of such areas can frequently be had by wells sunk to the porous material from the bottoms of drains.

The depth and location of drains will be governed by local conditions. They must be so disposed as to produce a flow from the porous materials, and they should carry the collected water to a natural waterway without allowing it to be lost again in the subsoil. Field-crop roots vary in depth from a few inches to 4 feet. Capillary action will ordinarily raise water from 18 inches to 42 inches depending on the character of the soil. The character of the surface soil is an important factor in determining the quantity of water which will be thus raised and evaporated; mulching reduces this quantity. The depth of drains will be controlled largely by these two factors.

In addition, the depth to which drains must be constructed will depend largely on the depth to the several water-bearing strata, it being frequently necessary to go to greater depths than questions of root length and capillary action would require, in order to reach pervious strata. A knowledge of surface topography, of the elevation and slope of the groundwater table, and of the water-bearing properties of the subsoils through which these waters must pass is essential to drainage-works design.

The collection and arrangement of the underground data are relatively difficult but proportionately important. The most thorough investigations reveal only partly the existing conditions. In uniform subsoils a few borings or test pits are sufficient for yielding the necessary information. Where the subsoil is not uniform as regards character and thickness, and the manner of percolation is erratic, elaborate data are required.

The most satisfactory method of obtaining and recording such information is to run surface profiles, plot these to a suitable scale, and record on the sections the data yielded by excavations along the profile. For borings, which are used when possible, an ordinary hand-auger is suitable; depths of 30 feet have been thus reached. In caving soil, or when a series of readings will be required to determine the height of the water table, a light casing may be employed. In heavy gravels, which the auger cannot penetrate, test pits are used. The distance between parallel sections will range from 200 feet to half a mile. The borings may be spaced as close as 50 feet, this spacing depending on local conditions.

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NEW DESIGN FOR SHORE PROTECTION

NATURE OF COAST EROSION AND REQUIREMENTS OF DEFENSE WORKS

Ralph Bennett—Engineering News

THE height, length and velocity of shoal-water waves are controlled, not by the energy stored in deep-sea waves, but by the effect which depth has on them, and the strength of the sea defense required at any point is as much or more a function of the depth of the shore waters during storms than of its exposure to the wind and waves of the open sea. Therefore the first step in coast protection is to form a beach.

By proper regard for the phenomena outlined, beaches can be built up and protected, but consideration must always be had for the variations in action at different times and seasons; slow accumulation during favorable weather must be balanced against rapid depletion during storms.

In Figure 1 are shown sections of various coast-protection works abroad and in this country. They have been reduced to the same scale

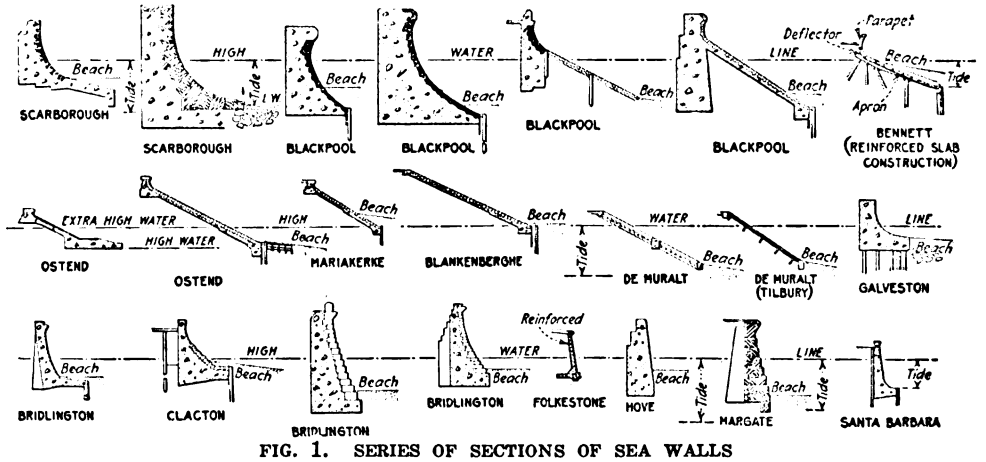

FIG. 1. SERIES OF SECTIONS OF SEA WALLS

While a beach cannot be made absolutely stable, its alterations can be defined within upper and lateral limits and maintained below the danger point. The action of the water tends to erode a beach or build it up until a position of equilibrium is established for that particular degree of agitation. Beach movement is largely governed by the direction of the wind, the nature of the beach material and the character of the shore currents. The longitudinal movement under the influence of variously generated shore currents is called littoral drift and must be taken into account.

and referred to the high-water line. While varying conditions show a rather wide variation in dimensions, the designs in general approximate a definite system conforming to theoretical requirements. Figure 2 represents a design proposed by the author which is believed to best satisfy the requirements laid down.

A sea wall supports a backfill on one side and an intermittent water pressure on the other. It must be firmly founded, homogeneous, arranged to destroy as much as possible of the energy in the wave before it reaches the top of the wall, and to ex-

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clude all live water from behind itself. A curved reinforced-concrete deck slab, as shown in Figure 2, having a variable thickness and supported by reinforced-concrete beams on piling answers every requirement of the problem in an elegant manner and at the least cost.

Any piece of coast-defense construction consists of the groins, the apron, the deflecting wall and the parapet, the last three parts combined into an integral structure. The groins are ridges or fences running out to sea, more or less perpendicular

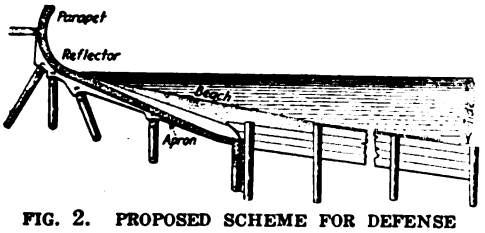

FIG. 2. PROPOSED SCHEME FOR DEFENSE WORKS

to the coast line and intended to control littoral drift. They may be constructed of almost any material; massive masonry used to be favored but timber is today exceedingly common. The spacing and height will be determined by a study of conditions existing. Usually the groin will start at above high water or at the face of the sea wall and extend to below low water. Its height as first installed may be nominal, with provision of posts for carrying it up as sand is accumulated. But the most stable beaches are formed by low walls which catch enough sand to cover themselves and allow all excess to flow past; these maintain the leeward beaches without erosion and cause the least possible changes from the natural beach form.

The groins confine within rather narrow limits the material needed for any particular stretch of shore, the seas and consequently the material being permitted to move for the most part only up and down. In practice, a good deal of material is carried down below the control of the groins and is swept away by currents; some at the top is dried and blown away; and a slight action of littoral currents between the groins will wear away the sand on their leeward side and heap it up on the windward. As soon as the accumulation becomes high enough, it overflows and the littoral drift is reëstablished, the sand entering the groin system at the windward side and leaving it at the leeward as under normal conditions.

The spacing of the groins which would be most suitable for maintaining under-water beach conditions may not be close enough to hold the upper sands to the desired plane of the beach lengthwise. In such case short inshore groins can be introduced to advantage.

The function of the sea wall proper is to define the upper range of the seas, maintain the position of the cliffs or embankments of the shore and control the drift of the upper sand. At the point where the crest of the wave falls the wall receives maximum pressure so far as wave action is concerned. It should be hard, smooth and impervious. Its shape should preclude secondary shocks from projecting faces or pockets. Its stability under the static load behind and the intermittent moving load on its face will be largely dependent on the proper determination of the amount and direction of the static load. It will be backed by sand on both the sea and the land sides and, since wet sand when agitated will flow freely, there must be no break to allow the backfill to be lost, while the water discharge must not erode the sand at the toe of the wall.

The securing of a proper foundation for a sea wall is one of the most difficult problems in its construction. Resting on sand, it is only stable when the sand is confined. The beach

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sand is anything but confined before the wall is built and its building will usually set up currents scouring its face. Even with proper groins, there will be times when conditions are being reëstablished in which the sea will tend to cut against the wall. Ground water will start channels and enlarge them and animal burrows will be enlarged into trenches by storm water. The only safe foundation is piling. Groups of piles part vertical and part inclined will provide a base absolutely stable and independent of the superficial wear of the surface sands. The piles may be of wood or concrete, but, since they will in most cases be in wet ground, wood is usually satisfactory. The piles must be long enough to resist dead load, erosion, uplift and reversal of loading and must be firmly joined to the concrete structure.

The apron is the lowest portion of the sea wall; it extends the slope of the beach sands up to the base of the deflector. It must receive the incoming waves without serious disturbance and deliver the backwash to deep water without allowing it to cause damage. It should extend far enough below the permanent beachline to obviate any chance for scour. It will increase in thickness from its lower lip to the point where it joins the deflector; the sand blanket will absorb the wave shocks on the lower, thinner portion, and under this section the underlying sand will almost surely be in contact with the concrete and will tend to support it. Reinforcement is needed only as a precaution against extraordinary conditions.

The apron merges gradually into the deflector. This latter, lying between wind and water, should be a thick, heavy slab arranged to distribute all local shocks to the unloaded portions of the wall. It receives the impact of the waves and the battering of floating material. It must be constructed and arranged to resist the shocks received both at low tide and at high. It should have a hard resilient surface and should be non-absorbent so as not to flake off. It should have no large open joints, permitting the water to enter and subject the back to shock. It should be stable even when deprived of its backfill.

The shape of the deflector curve will be determined by the shape and size of the maximum waves to be resisted. The lower edge should deliver the back wash from the wall to the apron with an easy sweep avoiding shock and scour. The curve at the point where the severest seas at high tide are tripped should be such that the falling water shall be received by a cushion of water from the front edge of the wave or else shall slide up with little shock. The cushioning of the fall is the most satisfactory method of receiving the wave shock but it is difficult to compass with a steep-faced wall; many waves must impinge on the steeper portions. A combination of cushioning and sliding action is usually obtained.

The parapet takes care of the course of the water after its motion has been changed from the horizontal to an inclined upward sweep. In general it will have a gradual outward curve so that when the water has reached its upper limit of travel it will fall back into the sea and not behind the wall. With proper design the spent water will dissipate its energy in breaking up the incoming surf. As this curve must sometimes be separated from the deflector by a stretch of flat or nearly flat wall, it must start to overhang at a very gentle rate, increasing this, however, as it gains in height. An abrupt curve will not control a thick wave. A smooth surface, gradual curve and ample height will reduce the effect of buffeting.

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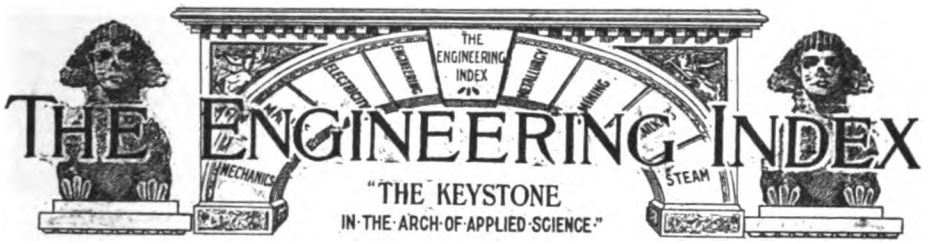

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CIVIL ENGINEERING

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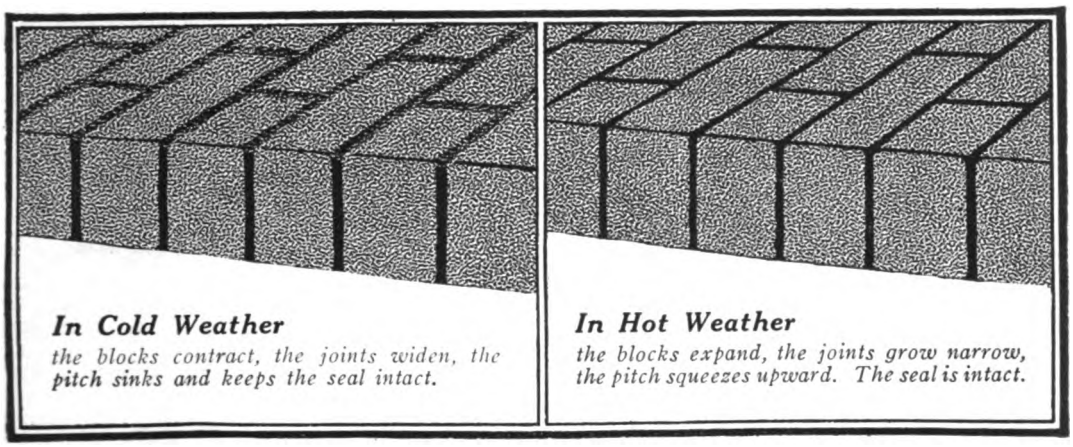
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land; straightening, bank protection, etc. Ills. 1600 w. Schweiz Bau—Sept. 18, 1915. No. 64824 B.

Paving River-Beds with Concrete. New system. Ills. 1200 w. Sci Am—Oct. 23, 1915. No. 65171.

MISCELLANY

Engineering

Idealism and Art in Engineering. Charles D. Marx. Address at annual convention, in San Francisco, Cal., Sept. 16, 1915. 6500 w. Pro Am Soc of Civ Engrs—Oct., 1915. No. 65282 D.

Engineering History

Ancient and Modern Engineers—Comparisons, Reflections and Tendencies. Sam. Boswell. Address; broad review. Manch Assoc Engrs—Oct. 9, 1915. No. 64872 N.

Law

Law and Engineering—Some Points of Contact. Sydney G. Turner. Read before the Soc. of Engrs., London. 5000 w. Archt, Lond—Oct. 8, 1915. No. 65193 A.

Panama-Pacific

Engineering Features of the Panama-Pacific International Exposition. Guy L. Bayley. Unusual features of interest to engineers. Ills. 13500 w. Jour Am Soc of Mech Engrs—Oct., 1915. No. 64788 A.

BOOK NOTICES

Architects

New York Society of Architects' Year Book. Size, 6″ x 9″; 240 pp. Ills. New York.

Contains variety of information, including summaries of building laws and allied legislation.

Concrete

Simplified Reinforced Concrete Mathematics. By Melvin D. Casler. Size, 5 x 7″; pp. 66. Ills. Price, $1.00. New York: D. Van Nostrand Co.

Series of practical formulas.

Structural Steel

R. A. Skelton & Co.'s Handbook No. 16. Structural Steel. Size, 6¾ x 8¾″; pp. 320. Ills. Price, $4. London: R. A. Skelton & Co.

Tables of properties of most of the common sections of steel and other useful tables.

Surveying

Practical Surveying. By Ernest McCullough. Size, 5 x 7″; pp. 401. Ills. Price, $2. New York: D. Van Nostrand Co.

General treatment designed for other than technically trained engineers; unusually practical.

ELECTRICAL ENGINEERING

COMMUNICATIONS

Cables

The New London-Birmingham-Liverpool Telephone Cable. Underground cable connecting these cities. Ills. 1000 w. Engr, Lond—Sept. 17, 1915. No. 64685 A.

Military Telephones

Telephone Modern Warfare and Military Communication. Ills. 2500 w. Telephony—Oct. 9, 1915. No. 64975.

Motor Trucks

Special Uses of Motor Trucks in Telephone Construction. W. J. Sommers and W. M. Van Deusen. Required characteristics. Ills. 3000 w. Telephony—Oct. 16, 1915. No. 65083.

Pole Holes

Some Interesting Data Relative to Blasting Pole Holes. Abstract of booklet by the Du Pont Co. Methods for various depths. Ills. 1500 w. Telephony—Oct. 23, 1915. No. 65247.

Poles

Recent Results Obtained from the Preservative Treatment of Telephone Poles. F. L. Rhodes and R. F. Hosford. Ills. 14500 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64767 D.

Radiotelegraphy

Radiotelegraphic Investigations. Undertaken by Committee of British Assn. 1700 w. Elect'n, Lond—Sept. 24, 1915. No. 64912 A.

Note on the Resistance of Radiotelegraphic Antennas. L. W. Austin. 600 w. U S Bureau of Stand, Sci paper 257—Oct. 16, 1915. No. 65300 N.

The Capacity of Aerials of the Umbrella Type. G. W. O. Howe. Read before Sec. G, British Assn. Calculations and method. 1500 w. Elect'n, Lond—Sept. 17, 1915. No. 64665 A.

A Note on "Earth Resistance." E. W. Marchant. Read before Sec. G, British Assn. Experiments with three types of earth plates. 700 w. Elect'n, Lond—Sept. 17, 1915. No. 64671 A.

Recent Advances in Wireless Measuring Instruments. Herbert T. Wade. Instrument for determining logarithmic decrement of transmitters. Ills. 1500 w. Sci Am—Oct. 23, 1915. No. 65170.

Wireless Telegraphy and Weather Forecasts. Effect of climate disturbances. From report to Sec. A, British Assn. 1500 w. Engr, Lond—Sept. 17, 1915. No. 64686 A.

Radiotelephony

Long Distance Wireless Telephony. Brief account of recent tests. Ills. 800 w. Sci Am—Oct. 9, 1915. No. 64790.

Voice Carried 4900 Miles by Radio. Wireless telephonic communication from Washington, D. C., to Honolulu. Com-

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ments by experts. 2500 w. Elec Wld—Oct. 9, 1915. No. 64949.

Rates

Investigation Furnishes Basis for Rules in Oregon. Results of an investigation of rates, charges, and regulations of the Pacific Telephone & Telegraph Co. 3000 w. Telephony—Oct. 16, 1915. No. 65084.

Telegraphy

The Story of the Telegraph. W. H. Spain. Reviews development. Discussion. 6000 w. Pro St Louis Ry Club—Sept. 10, 1915. No. 65121.

Telephony

The Study of Transmission Problems by Means of Vectors. E. W. Kellogg. Connection between telephonic transmission and mathematical theory of electric wave propogation. 3500 w. Telephony—Oct. 23, 1915. Serial, 1st part. No. 65246.

ELECTRIC CIRCUITS

Circuit Breakers

Discussion on "Oil Circuit Breakers," (Randall) New York, Feb. 17, 1915. Ills. 3500 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64776 D.

Wiring

The First Installation of Bare Concentric Wiring in America. Features of three houses at Boston wired experimentally. Ills. 2000 w. Elec Wld—Oct. 9, 1915. No. 64950.

ELECTRO-CHEMISTRY

Electrodes

Electric Furnace Electrodes — Their Manufacture and Use. Charles A. Barnett. Arc and resistance furnaces. Ills. 3500 w. Sib Jour of Engng—Oct., 1915. No. 64965 A.

Electroplating

Electro-Plating with Cobalt. Herbert T. Kalmus and others. Part III of series. Report of research work. 69 pp. Can Dept of Mines—No. 334. No. 64879 N.

Pacific Coast

Electro-Chemical and Electro-Metallurgical Possibilities of the Pacific Coast. J. W. Beckman. Available power, materials and industries. Ills. 3500 w. W Engng—Oct., 1915. No. 64999 A.

Primary Cells

Chemistry of Primary Galvanic Cells and General Discussion of Storage Cells. E. A. Logan. Study, giving details of types. 7000 w. Pro U S Naval Inst—Sept.-Oct., 1915. No. 65138 B.

ELECTRO-PHYSICS

Conduction

Conduction of Electricity Through Metals. O. J. Thomson. Extract from a paper before the Phys. Soc. Effects discovered by Kamerlingh Onnes. 2000 w. Elect'n, Lond—Oct. 8, 1915. No. 65199 A.

Dielectrics

On the Relation Between the Alternating-Current Conductivity of a Dielectric and Its Change of Capacity with Frequency. G. E. Bairsto. 1200 w. Elect'n, Lond—Oct. 15, 1915. No. 64896 A.

Harmonics

Decomposing Magnetic Fields into Their Higher Harmonics. H. Weichsel. Methods employed. 2200 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64771 D.

Heating

Thermal Characteristics and Intermittent Rating. Note on the general theory of heating and cooling and the load-factor method is described and illustrated. 1200 w. Elect'n, Lond—Oct. 15, 1915. Serial, 1st part. No. 64897 A.

Hysteresis

The Effect of Displaced Magnetic Pulsations on the Hysteresis Loss of Sheet Steel. L. W. Chubb and Thomas Spooner. Investigation. Ills. 2500 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64766 D.

The Unsymmetrical Hysteresis Loop. John D. Ball. Results and analyses of tests to determine losses. 3500 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64764 D.

Insulation

Electric Strength of Insulating Materials Under Mechanical Pressure. F. Kock. Abstract trans. from *Elektro Zeit.* Fluid, viscous, and solid insulators. 3000 w. Elect'n, Lond—Oct. 8, 1915. No. 65197 A.

The Volume Resistivity and Surface Resistivity of Insulating Materials. Harvey L. Curtis. Factors and influences. 2000 w. Gen Elec Rev—Oct., 1915. No. 64599 A.

Magnetism

The Heating of Iron When Magnetized at Very High Frequencies. N. W. McLachlan. Read before Sec. G, British Assn. Tests for losses, permeability and skin effect. 2000 w. Elect'n, Lond—Sept. 17, 1915. No. 64669 A.

The Magnetostriction and Resistance of Iron and Nickel. C. W. Heaps. Experiments on contraction and resistance of iron and nickel in magnetic field. 1600 w. Elect'n, Lond—Oct. 1, 1915. No. 65029 A.

Oscillations

Electric Oscillations in Coupled Circuits—A Class of Particular Cases. W. H. Eccles and A. J. Makower. Read before Sec. G, British Assn. Conditions causing oscillations of single frequency. Diagrams. 1500 w. Elect'n, Lond—Sept. 24, 1915. No. 64911 A.

Wave Distortion

Discussion on "Distortion of Alternating-Current Wave Form Caused by Cyclic Variation in Resistance," (Bedell and Mayer), New York, Feb. 18, 1915. 2000 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64777 D.

GENERATING STATIONS

Construction Costs

Unit Construction for Hydroelectric System. Graphical presentation. Diagrams. 700 w. Elec Wld—Oct. 23, 1915. No. 65230.

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Automatic Control. C. W. Place. How far advisable to apply? Typical examples. 2500 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64770 D.

Automatic Electric Control for Hydraulic Accumulators. Advantages, apparatus. Ills. 1000 w. Engr, Lond—Sept. 24, 1915. No. 64930 A.

Sprague-General Electric PC Control. C. J. Axtell. Details of construction and operation of electro-pneumatic system. Ills. 2300 w. Gen Elec Rev—Oct., 1915. No. 64597 A.

Detroit

The Connors Creek Plant of the Detroit Edison Company. C. F. Hirshfeld. Detailed description. Discussion. Ills. 8000 w. Jour Cleveland Engng Soc—Sept., 1915. No. 65125 A.

Fort Wayne

Fort Wayne Station Rebuilt. Thomas Wilson. Turbo generators removed from second floor to ground level because of vibration. Ills. 3000 w. Power—Oct. 19, 1915. No. 65114.

Havana

Havana's New Power Station. T. C. Ulbright. Ills. 1500 w. Sib Jour of Engng—Oct., 1915. No. 64961 A.

Hydro-Electric

The Effect of Hydro-Electric Power Transmission Upon Economic and Social Conditions, with Special Reference to the United States of America. Frank G. Baum. Abstract of paper read at Int. Engng. Cong. Shows benefits derived. 4000 w. Elect'n, Lond—Oct. 8, 1915. No. 65200 A.

Continuous Utilization of Water Power and the Means Thereto (Restlose Ausnutzung der Wasserkräfte und deren Hilfsmittel). C. Reindl. Methods of storing energy. Ills. 3200 w. Zeit f d ges Turbinen—Sept. 20, 1915. Serial, 1st part. No. 64832 B.

Cohoes, N. Y., Hydro-Electric Development. Warren O. Rogers. General description. Ills. 3000 w. Power—Oct. 5, 1915. No. 64735.

Combined Generating and Substation. Deerfield River. Ills. 2000 w. Prac Engr, Chicago—Oct. 15, 1915. No. 65042.

Hydroelectric Power from Snow-Clad Fujiyama. C. Tsukamoto. Plant of Katsuragawa Hydroelectric Co., Japan., serving Tokio over a 53-mile, 77000-volt line. Ills. 2000 w. Elec Wld—Oct. 23, 1915. No. 65229.

The State and the Hydro-Electric Power Problem in Norway. Editorial review of report of the Royal Commission. Map. 3500 w. Engng—Oct. 8, 1915. No. 65210 A.

Operating and Control Features of an Hydroelectric Plant. Description of Parr Shoals development, Broad River, S. C. Ills. 3500 w. El Age—Oct., 1915. No. 64816.

The Combined Operation of Steam and Hydraulic Power in the Pennsylvania Water and Power Company System. John Abbet Walls. Experience on erratic river. 4500 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64765 D.

Swedish State Hydro-Electric Power-Station at Parjus. Complete description. Ills. 4500 w. Engng—Oct. 15, 1915. Serial, 1st part. No. 64886 A.

The Stave Falls Power Development of Western Canada Power Company, Limited. R. F. Hayward. History and detailed description. Ills. 43 pp. Can Soc of Civ Engrs—Oct. 7, 1915. No. 65100 N.

Construction Elements of Tallulah Falls Development. Charles G. Adsit, assisted by W. P. Hammond. Description with unit costs. Ills. 14000 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64773 D.

Isolated Plants

Meeting Diversified Requirements. An example of modern isolated plant practice. Ills. 1500 w. Prac Engr, Chicago—Oct. 1, 1915. No. 64604.

Manchester

Manchester Electricity Supply. S. L. Pearce. Read before Sec. G, British Assn. Extension scheme. Ills. & Plate. 4500 w. Engng—Sept. 24, 1915. No. 64924 A.

Municipal Plants

Electric Light Plant of South Norwalk, Conn. Prosperous plant; methods of accounting. Ills. 2000 w. Munic Engng—Oct., 1915. No. 65008 A.

Power Plants

New Penn Central Power Co.'s Williamsburg Plant. Warren O. Rogers. Steam-turbine plant supplying 45000-volt a.c. to Altoona, Pa. Ills. 3000 w. Power—Oct. 26, 1915. No. 65248.

Rates

Rates and Rate Making. Paul M. Lincoln. Necessity of recognizing load factor; new method of measuring power factor and volt-amperes. 12500 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64760 D.

Tendencies in Central-Station Rate-Making. Frederic Nicholas. Authorized interview with W. W. Freeman, Cincinnati, Ohio. 2000 w. Elec Wld—Oct. 23, 1915. No. 65228.

The Problem of the "Point-Five" Tariff. Difficulties and arguments to prove rateable value basis not equitable. 1500 w. Elec Rev, Lond—Oct. 1, 1915. Serial, 1st part. No. 65026 A.

Selling Current on a Small Margin. Thomas Wilson. Combination at Goshen, Ind. Ills. 2000 w. Power—Oct. 12, 1915. No. 64987.

GENERATORS AND MOTORS

Armatures

A Note on the Distribution of Flux Around a Continuous-Current Armature. Bernard Hague and Francis F. H. Schroeder. Investigations and results.

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A Self-Adjusting Commutating Device. Miles Walker. Abstract of paper read before Sec. G, British Assn. Ills. 1200 w. Elect'n — Sept. 17, 1915. No. 64666 A.

Induction Motors

The Estimation of the Dispersion Coefficient of Three-Phase Induction Motors and Its Application to Their Design. E. A. Biedermann. 2500 w. Elect'n, Lond—Oct. 15, 1915. Serial, 1st part. No. 64895 A.

The Repulsion Start Induction Motor. James L. Hamilton. General characteristics, mechanical design and construction. Ills. 7000 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64768 D.

Insulation

Experimental Data Concerning the Safe Operating Temperature for Mica Armature-Coil Insulation. F. D. Newbury. Three series of tests on first 3750 kv-a. generator installed at Niagara Falls. Ills. 3800 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64775 D.

Leakage Flux

Leakage Flux Calculations. John F. H. Douglas. Greater accuracy in calculations desirable; suggest improvements in theory. 2500 w. Elect'n, Lond—Sept. 17, 1915. No. 64670 A.

Prime Movers

Metropolitan Needs and Sizes of Prime Movers. Tendencies point to increase in size of turbo-generators; feasibility of operating 50000-kw. units. Ills. 1500 w. Elec Wld—Oct. 9, 1915. No. 64951.

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Power Consumption of Railway Motors. H. L. Andrews and J. C. Thirlwall. Economies from equipment suited to service. Ills. 3500 w. Gen Elec Rev—Oct., 1915. No. 64591 A.

Rotary Converters

Some Properties of the Rotary Converter. O. H. Henschel. General theory voltage, current relations. Diagrams. 2500 w. Prac Engr, Chicago—Oct. 1, 1915. Serial, 1st part. No. 64607.

Single-Phase Motor

Single-Phase Squirrel-Cage Motor with Large Starting Torque and Phase Compensation. Val. A. Flynn. Development; and theory of operation. Ills. 6000 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64761 D.

Speed Regulation

Direct-Current Motor Speed Regulation by Resistance in the Armature Circuit, with Special Reference to the Diverter Method. Thomas Carter. 2500 w. Elect'n, Lond—Oct. 1, 1915. Serial, 1st part. No. 65027 A.

ILLUMINATION

Progress

Report on Progress in Illumination. Presented by committee before the Illuminating Engng. Soc. 6000 w. Gas Age—Oct. 1, 1915. Serial, 1st part. No. 64691.

Searchlights

See *Marine and Naval Engineering.*

Service

How Can Gas and Electric Companies Under One Management Render the Best Light Service? From a paper by A. B. Spaulding and N. H. Potter, before the Ill. Engng. Soc. 2800 w. Am Gas Lgt Jour—Oct. 4, 1915. No. 64704.

Shops

Memorandum on the First Report of the Departmental Committee on Lighting in Factories and Workshops. Also editorial. Brief summary of report and appendices. 3500 w. Archt, Lond—Sept. 17, 1915. No. 64663 A.

MEASUREMENT

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Measuring the Current in D. C. Circuits. Otto A. Knopp. Does not require circuit to be opened; suited to large and small measurements. Ills. 1000 w. Elec Wld—Oct. 2, 1915. No. 64698.

Meters

Electric Meters, Testing and Adjustment. (Ueber Elektrizätszahler, Zählerprüfung and Zählereicheinrichtungen). J. Schmidt. History, types, etc. Ills. 1200 w. Elektrotech Rund—Sept. 8, 1915. Serial, 1st part. No. 64804 B.

Photometry

The Establishment of Photometry on a Physical Basis. Herbert E. Ives. Prepared for Int. Elec. Cong. Investigations toward simplification of light measurement. Ills. 7000 w. Jour Fr Inst—Oct., 1915. No. 64793 B.

Resistance

Construction of Primary Mercurial Resistance Standards. F. A. Wolff, M. P. Shoemaker, and C. A. Briggs. Methods of calculation, correcting, etc.; experimental details, and supplementary measurements. Ills. 90 pp. U S Bureau of Stand, Sci paper 256—Oct. 9, 1915. No. 65299 N.

Rheostats

Water Rheostats. N. L. Rea. Use in making heat runs and other tests on large generators. 1200 w. Gen Elec Rev—Oct., 1915. No. 64600 A.

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The Calculation of the Long Distance Transmission Line Under Constant Alternating Voltage. George R. Dean. Mathematical solutions and formulas. 3000 w. Pro Am Inst of Elec Engrs—Oct., 1915. No. 64762 D.

POWER APPLICATIONS

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Electricity in Agriculture. Carl J. Rohrer. Its many uses. Ills. 3300 w.

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Sci Am Sup—Oct. 23, 1915. Serial, 1st part. No. 65180.

Electric Vehicles

The Electric Vehicle as a Business Builder. From a paper by Q. A. Brackett, read before the Indiana Elec. Lgt. Assn. Possibilities and characteristics of battery-Charging load. 2000 w. Elec Rev & W Elect'n—Oct. 16, 1915. No. 65089.

Harvester Works

Electricity in Harvesting Machinery Works. Details; advantages. Ills. 3500 w. Elec Rev & W Elect'n—Oct. 23, 1915. No. 65227.

Machine Shops

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Electricity in Slate Quarrying. R. C. Berlin. Use in America. 4500 w. Quarry—Oct., 1915. No. 65025 N.

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General Notes on Grounding. H. M. Wolf. Types; merits. 3500 w. Gen Elec Rev—Oct., 1915. No. 64598 A.

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Transmission Line Construction for Mountain Districts. H. M. Somerville. How wires are kept apart. Ills. 1500 w. Elec Wld—Oct. 16, 1915. No. 65067.

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Protection and Control of Industrial Electric Power. Dr. Charles P. Steinmetz. Considers briefly disturbances and devices for protection. Ills. 3300 w. Gen Elec Rev—Oct., 1915. No. 64596 A.

Regulators

The Siemens-Schuckert Quick Regulator. G. E. Grau. Abstract from *Elektro Zeit.* Detailed description. Ills. 2000 w. Elect'n, Lond—Sept. 24, 1915. No. 64914 A.

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Arcing Characteristics of Air-Break Switches. Charles E. Bennett. Tests and interpretation. Ills. 1500 w. Elec Wld—Oct. 16, 1915. No. 65064.

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Presidential Address by Mr. A. H. Dykes to the Association of Supervising Electricians. Scheme for training boys. Discussion. 3500 w. Elect'n, Lond—Oct. 8, 1915. No. 65198 A.

The Teaching of a Trade. R. I. Clegg. Methods of training apprentices in industrial handicraft. Discussion. 10500 w. Jour Cleveland Engng Soc—Sept., 1915. No. 65127 A.

Cripples

The Re-Education and Preparation for Work of the Wounded and Mutilated from the War (La reëducation, et la réadaptation au travail des blessés et des mutilés de la guerre). Borne. Problem and solution. 22 pp. Bull Soc d'Encour—July-Aug., 1915. No. 64810 C + D.

Electrical Engineering

The New Advanced Course in Electrical Engineering at Columbia University. W. I. Slichter. Professional course. Ills. 2000 w. Gen Elec Rev—Oct., 1915. No. 64590 A.

Experiment Stations

The Engineering Experiment Station of the University of Illinois. Ellery B. Paine. Organization for engineering research; facilities and methods. 2500 w. Pro Am Inst of Elec Engr—Oct., 1915. No. 64769 D.

Research

The Value of Industrial Research. W. A. Hamor. Methods employed; service of Mellon Institute. 2500 w. Sci M—Oct., 1915. No. 64589 A.

The Value of Research to Industry. Francis Mills Turner. How they can cooperate to the best advantage. Work of Mellon Institute. Ills. 3500 w. Can Min Jour—Oct. 15, 1915. No. 65112.

Sales Work

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Educational Activities at Norton Companies. E. H. Fish. Training in all lines of company work at Worcester. N A C S Bull—Oct., 1915. No. 64820 A.

FINANCE AND COSTS

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Bankrupt Railroads

Railroad Bankruptcy. List and information of roads now operated by receivers. Map. 1600 w. Ry Age Gaz—Oct. 15, 1915. No. 65060.

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How the Contractor Can Know Where He Stands. Louis W. Moxey, Jr. System found effective. 2500 w. Elec Wld—Oct. 16, 1915. Serial, 1st part. No. 65068.

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The Cost per Pound of Electrical Machinery. Leonard A. Doggett. Aims to give partial answer. 600 w. Elec Wld—Oct. 2, 1915. No. 64697.

Expense Distribution

Distribution of Fixed Charges in Manufactories. N. T. Ficker. Sixth paper takes up depreciation, insurance, taxes, interest, and other charges. 4500 w. Eng Mag—Nov., 1915. No. 65309 A.

Machine Shops

A Jobbing Machine Shop Cost System. Records for material and labor. Ills. 800 w. Ir Age—Oct. 14, 1915. No. 65013 A.

Mine Valuation

The Valuation of Metal Mines. T. A. Rickard. Read before Inst. Engng. Cong. Methods discussed and criticized. 6000 w. Min Pr—Oct. 9, 1915. No. 65017.

Mining Cost

Basic Principles of Mining Cost. James R. Finlay. Lecture at Columbia School of Mines. 1800 w. Sch of Mines Qr—April, 1915. No. 65118 B.

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Oil-Land Valuation

The Valuation of Oil-Lands and Properties. M. E. Lombardi. Abstract of paper before Int. Engng. Cong, San Francisco. Explains problem and methods used. 6000 w. W Engng—Oct., 1915. No. 65001 A.

Public-Utility Valuation

Foundation Principles of Utility Valuation with Special Application to Resettlement Plans. B. J. Arnold. Broad discussion. Ills. 42 pp. Am El Ry Assoc—Oct., 1915. No. 64844 N.

Why Appraisal Is Not Valuation. George Sidney Binckley. Considerations which cannot be measured. 4000 w. Eng Rec—Oct. 23, 1915. No. 65242.

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Interstate Commerce Commission Hearing on Valuation. Railroads urge Commission's co-operation. 3000 w. Ry Age Gaz—Oct. 8, 1915. No. 64940.

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Financial Problems as Affecting Tramways During War Time. Alfred Baker. Read before Munic. Tram. Assn. Suggestions for meeting acute problems. Discussion. 10500 w. Tram & Ry Wld—Oct. 14, 1915. No. 65286 A.

MANAGEMENT

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The Engineering Contractor. Halbert P. Gillette. Read at Am. Builders' Week Convention, San Francisco. Natural qualities, education, etc. 3300 w. Engng & Con—Oct. 20, 1915. No. 65167.

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Shop Efficiency. George H. Logan. Analysis of factors in administration. 3500 w. Ry Rev—Oct. 9, 1915. No. 64986.

The Application of Efficiency Principles. Fred H. Rindge, Jr. Especially human side of management. Ills. 3300 w. Min Pr—Sept. 25, 1915. No. 64626.

Organization

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Railway Shops

Railway Repair Shop Organization. Henry Gardner. Proper method. 3000 w. Ry Age Gaz (Mech Ed)—Oct., 1915. No. 64960 A.

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What Scientific Management Means to America's Industrial Position. Frank B. Gilbreth and Lillian Moller Gilbreth. Principles, practice, relation to industrial

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position of any country. 3000 w. An Am Acad of Pol & Social Sci—Sept., 1915. No. 64688 N.

The Individual in Modern Management. F. B. and L. M. Gilbreth. Relations aimed at and effect on human element. 3000 w. Ir Age—Oct. 7, 1915. No. 64779 A.

Small Consumers

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Year's papers on subjects within province of the Society.

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The Internal Combustion Engine. By H. E. Wimperis. Size, 5½ x 8½"; pp. 319. Ills. Price, $3.00. New York: D. Van Nostrand Co.

Brief text book for both students and engineers.

Drafting

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MINING AND METALLURGY

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CONDUCTING TRANSPORTATION

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

In the list below, *w* indicates a weekly publication; *b-w*, a bi-weekly; *m*, a monthly; *b-m*, a bi-monthly; *t-m*, a tri-monthly; *s-m*, a semi-monthly; *qr.*, a quarterly; *s-q*, a semi-quarterly, etc.

American Electrochemical Society. South Bethlehem.
American Foundrymen's Association. Cleveland.
American Gas Light Journal. *w*. New York.
American Inst. of Architects. *yr*. New York.
Amer. Jour. of Public Health. *m*. New York.
Amer. Jour. of Science. *m*. New Haven.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. d Arch Ital. *s-m*. Rome.
Applied Science. *m*. Toronto.
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Architectural Record. *m*. New York.
Architecture and Building. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automobil Rundschau. *s-m*. Berlin.

Beton und Eisen. *s-m*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. New York.
Brickbuilder. *m*. Boston.
Bull. Am. Inst. Mining Engrs. *m*. New York.
Bull. Am. Iron & Steel Inst. *m*. New York.
Bull. Am. Ry. Engng. Assn. *m*. Chicago.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bull. Can. Min. Inst. *m*. Montreal.
Bull. Soc. Int. d'Électriciens. *m*. Paris.
Bulletin of the Univ. of Wis. Madison.
Bull. Int. Railway Congress. *m*. Brussels.
Bull. Univ. of Illinois. Urbana, Ill.
Bureau of Mines. Washington.
Bureau of Standards. Washington.

Canadian Engineer. *w*. Toronto and Montreal.
Canadian Mining Journal. *b-w*. Toronto.
Chem. Met. Min. Soc. S. Af. *m*. Johannesburg.
Coal Age. *w*. New York.
Colliery Engineer. *m*. Scranton.
Colliery Guardian. *w*. London.
Commercial Vehicle. *s-m*. New York.
Commonwealth Engineer. *m*. Melbourne.
Compressed Air. *m*. New York.
Concrete-Cement Age. *m*. Chicago.
Cornell Civil Engineer. *m*. Ithaca.

Dept. of Agri. Washington.

Economic Geology. *s-q*. New Haven.
Electrical Engineering. *m*. New York.
Elec. Review and W. Elec'n. *w*. Chicago.
Electrical Review. *w*. London.
Electrical World. *w*. New York.
Electric Journal. *m*. Pittsburgh, Pa.
Electric Railway Journal. *w*. New York.
Electric Traction. *m*. Chicago.
Electrician. *w*. London.
Elektrische Kraftbetriebe u Bahnen. *w*. Munich.
Elektrochemische Zeitschrift. *m*. Berlin.
Elektrotechnik u Maschinenbau. *w*. Vienna.
Elektrotechnische Rundschau. *w*. Potsdam.
Engineer. *w*. London.
Engineering. *w*. London.
Engineering and Contracting. *w*. Chicago.
Engineering Contractor. *m*. New York.
Engineering Magazine. *m*. New York and London
Engineering and Mining Journal. *w*. New York.
Engineering News. *w*. New York.
Engineering Record. *w*. New York.
Eng. Soc. of Western Penn. *m*. Pittsburgh.

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Feuerungstechnik. *s-m.* Leipzig.
Foundry. *m.* Cleveland, Ohio.

Gas Age, *b-m.* New York.
General Electric Review. *m.* Schenectady.
Génie Civil. *w.* Paris.
Geological Survey. Washington.
Giesserei-Zeitung, *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Glückauf. *w.* Essen, Germany.

Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.

Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Turin.
Industria. *w.* Milan.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trade Review. *w.* London.
Iron Trade Review. *w.* Cleveland, Ohio.

Jour. of Accountancy. *m.* New York.
Jour. Am. Brass Founders' Assn. Buffalo.
Jour. Am. Soc. Heat. & Vent. Engrs. *qr.* N. Y.
Jour. Am. Soc. Mech. Engrs. *m.* New York.
Jour. Am. Soc. of Naval Engrs. *qr.* Washington.
Jour. Asso. Eng. Societies. *m.* St. Louis.
Jour. Boston Soc. of Civil Engrs. *m.* Boston
Jour. Cham. Mines, W. Austral. *m.* Kalgoorlie.
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Journal of Geology. *s-q.* Chicago.
Journal Franklin Institute. *m.* Philadelphia.
Journal N. E. Water Works Assn. *qr.* Boston.
Journal of the Society of Arts. *w.* London.
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Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Jour. Western Soc. of Engineers. *b-m.* Chicago.
Jour. of Worcester Poly Inst. Worcester, Mass.

La Nature. *w.* Paris.

Machinery. *m.* New York.
Madison Engineer. *m.* Madison.
Manufacturers' Record. *w.* Baltimore.
Marine Engr. and Naval Archt. *m.* London.
Marine Review. *m.* Cleveland, Ohio.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *b-m.* New York.
Mining and Engineering World. *w.* Chicago.
Mining and Scientific Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* London.
Monitore Tecnico. *t-m.* Milan.
Montanistische Rundschau. *w.* Vienna.
Motorwagen. *t-m.* Berlin.
Municipal Engineering. *m.* Indianapolis.
Municipal Journal. *w.* New York.

National Engineer. *m.* Chicago.
National Founders Association. *m.* Chicago.
Natl. Mach. Tool Bldrs. Assn. Worcester.
Nature. *w.* London.

Power. *w.* New York.
Practical Engineer. *s-m.* Chicago.
Practical Engineer. *w.* London.
Pro. Am. Inst. Electrical Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Water Works Assn. *yr.* Baltimore.
Pro. Brooklyn Engineers' Club. *yr.* New York.
Pro. Central Railway Club. *b-w.* Philadelphia.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. West. Pennsylvania. *m.* Pittsburgh.
Pro. Inst. of Civil Engineers. London.
Pro. Inst. of Electrical Engineers. London.
Pro. Inst. of Mechanical Engineers. London.
Pro. Inst. of Mining & Metallurgy. *m.* London.
Pro. Lake Superior Min. Inst. Ishpeming.
Pro. New York Railway Club. *m.* New York.
Pro. Railway Club of Pittsburgh. *m.* Pittsburgh.
Pro. St. Louis Railway Club. *m.* St. Louis.
Pro. U. S. Naval Inst. *qr.* Annapolis.
Pro. Western Railway Club. *m.* Chicago.

Quarry. *m.* London.
Queensland Government Mining Jour. *m.* Brisbane.

Railway Age Gazette. *w.* New York.
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Railway and Locomotive Engng. *m.* New York.
Railway Engr. *m.* London.
Railway Engng. & Maintenance of Way. *m.* New York.
Railway Gazette. *w.* London.
Railway Master Mechanic. *m.* New York.
Railway Review. *w.* Chicago.
Revista Marittima. *m.* Rome.
Rev. d'Electrochimie et d'Electrométall. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Générale des Chemins de Fer. *m.* Paris.
Revue Générale des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.

Safety Engng. *m.* New York.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *qr.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific American Supplement. *w.* New York.
Shipbuilder. *m.* Newcastle-on-Tyne.
Sibley Journal of Mech. Engng. *m.* Ithaca.
Signal Engineer. *m.* Chicago.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken.
Surveyor. *w.* London.

Telephone Engineer. *m.* Chicago.
Telephony. *w.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Soc. Nav. Arch'ts & Mar. Engrs., N. Y.
Trans. Illuminating Engng. Soc. New York.
Trans. Inst. Civil Engrs. of Ireland. Dublin.
Trans. Inst. of Engrs. & Ship. in Scotland. Glasgow.
Trans. Inst. Min. Engrs. *m.* London.
Travelers Standard. *m.* Hartford.

Werkzeugmaschine. *b-m.* Berlin.
Western Engineering. *m.* San Francisco.

Zeitschr. f. d. gesamte Turbinenwesen. *w.* Munich.
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THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD"

VOL. L JANUARY, 1916 No. 4

THE AMERICAN MERCHANT MARINE—RE-CREATION OF A VAST NEW INDUSTRY

By the Editor

THE startling facts presented in Mr. Gibboney's admirable paper which follows, should sink home to the clear comprehension of every reader of these pages. For they mean, inevitably, the immediate and very rapid development of a vast new American industry.

Ever since the Civil War, for full fifty years past, the whole American people have been so engrossed in the development of our great West, in the building of thousands of new cities and towns, in the construction and organization of our trans-continental railway systems, and especially in the eager development of all our varied and now enormous manufacturing industries, that both shipbuilding and our merchant marine have been all but completely neglected—because other lines of activity and investment were more profitable. But the great war in Europe has brought a sudden and startling change, and supplementing the information presented by Mr. Gibboney, it is well to weigh these significant facts:

Under date of December 19, 1915, Hon. Wm. C. Redfield, Secretary of Commerce, officially reports that:

"American shipyards have under construction now more vessels than ever before were building in the United States to add to an

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American merchant marine whose gross tonnage already is the largest in the country's history.

"Ninety-eight merchant vessels of more than 3,000 tonnage are being built or are under contract. These with many small vessels being constructed have a total tonnage of 761,511.

"Many big vessels are being built. Thirteen mentioned in the report are of more than 10,000 tons. Twenty are of tonnage between 7,000 and 10,000 and thirty-six are of from 5,000 to 7,000 tons. Eleven vessels are colliers, forty-seven oil vessels, thirty-four general freight vessels and six passenger and freight vessels."

Under date of December 8, 1915, Mr. H. L. Aldrich, the publisher of *International Marine Engineering*, writes:

"At first thought it seems a big amount of money for the Government to appropriate $50,000,000 for purchasing ships for use in the foreign trade. Let us leave aside all questions except the one important one of what will the $50,000,000 do?

"There are now under construction, in the shipyards *on the Atlantic Coast*, eighty-two ocean-going vessels, all of which will sail under the American flag. These vessels represent an expenditure on the part of their owners of $70,000,000. In this number I have not included a considerable fleet of vessels that have been contracted for since November, 1914, and that have already been delivered.

"All of these contracts represent prices far lower than what it would cost to duplicate the ships today. Indeed, all of us who know anything about the shipbuilding business know that many an attempt has been made to purchase vessels at twice what they cost. Only yesterday my attention was called to an offer of $800,000 each for two ships recently built at a cost of $425,000 each, and the shipowners simply laughed at the offer."

A fortnight ago the Standard Shipbuilding Company, with a capital of $3,000,000, was incorporated by New England and Western capitalists, with the announcement that they had acquired the extensive shipyard property of Townsend & Downey on Staten Island in New York harbor, and Mr. Wallace Downey of that firm, made this announcement on behalf of the Board of Directors, of which he is a member:

"Actual shipbuilding operations will begin in two months. We shall launch our first steel ship of 7,000 tons within a year. In the second year we will launch a steel ship every sixty days, and in the third year we will be able to launch a steel ship every thirty days.

"Under normal conditions before the war, the cost of shipbuilding materials in the United States was less than in foreign countries, but foreigners had an advantage in the cost of labor. Now their yard labor costs have increased materially, and I think the costs will never be as low again.

"I believe that by the standardization of types of vessels and by specialization in building, American shipbuilders will in the future be able to compete successfully with the shipbuilders of any other nation.

"Every shipyard on the Atlantic and Pacific Coast is now glutted with work at splendid prices.

"Merchant vessels are being sunk at the average rate of 10,000 tons a day. Foreign shipyards are devoted almost entirely to naval necessities, and the logical result is that the world's merchant tonnage is short. It will take many years to restore the normal ocean carrying trade of the world.

"Americans have the opportunity to become the shipbuilders of the future and establish the greatest all-American merchant marine that the world has ever seen."

Very recently also the New York *Journal of Commerce* has published a valuable series of special articles by its

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thoroughly well-informed Liverpool correspondent on the far-reaching influence of the opening of the Panama Canal, and from this high British authority we get these significant statements:

"The opening of the Panama Canal and the outbreak of the great European war will render the year 1914 historic in the annals of shipping. For one thing, we may see a great revival of American shipping. Before the twentieth century is much older we Britishers may see what we saw in the first half of the nineteenth—the United States merchant marine our chief rival on the ocean.

"In the coal export trade also, in which Britain has long held something like a monopoly, the Americans may now become keen competitors as a direct result of the opening of the great new canal. While our British shipping interests have paid a great deal of attention to the Panama Canal tolls question, and to the alteration the canal will effect in trading routes and so forth, there are at least two other important points in the general problem to which little thought has been given. One is the possibility of a great revival of United States shipping and shipbuilding. That would mean serious competition with our British industries. The other point relates to the comparative prices of British and American coal at the various coaling stations on the old Suez and the new Panama routes, respectively. In cases where the distance between western European and eastern American ports and those of the Orient, Australia, New Zealand, etc., is anything like the same via Panama as via Suez coal prices will be the dominating factor in deciding which way vessels will take and, of course, whether they burn American or British coal for the greater part of their voyages. Coal will play a big part in the revision and development of international trading routes.

"As announced by President Wilson, special measures are to be adopted for the revival of American shipping, for it is felt that unless the United States soon possesses a greatly augmented fleet of merchant ships the huge expenditure upon the Panama Canal will have been incurred mainly for the benefit of foreign shipping. Various schools of thought advocate various measures—some favor direct subsidies, some preferential canal tolls, some discriminating customs dues against foreign vessels and others favor the creation of a State shipping service. These are points for American statesmen to settle. We may be certain that some means will be adopted for the resuscitation of American shipping."

Then on the vexed question of the La Follette act, and the alleged burdens which it puts upon American ship owners, we now have this speaking testimony from no less an authority than Commander C. S. Stanworth of the United States Navy, retired. Writing from Norfolk, Va., to the *New York Times* under date of Dec. 14th, '15, he says:

"Sailors have for generations been outside the law that protects the ordinary man in his rights, and custom or common usage, that equally with law protects us in our relations to others, has always been invoked *against* any attempt to better the sailor's life.

Dragged aboard ship insensible from drugs or drink, he is told that he has signed the articles for the voyage and that two to three months of his future work has been paid in advance to the man who drugged him and lugged him on board. Ill-clad, ill-fed, hard-worked, he is at the mercy of the officers of the ship, whose code generally is that of brute force, and if he resists being knocked and kicked about, he renders himself liable to death for mutiny. If, when the ship arrives in port he attempts to escape from his slavery the law throws him in prison, and then returns him to his ship, and he pays the expenses.

"Such were the abuses, especially on American ships, that the law had to prescribe the food, and a certain amount of cubic airspace for his sleeping quarters. But the money he works for could be paid

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in advance to any one the Captain saw fit, that is any one except the sailor himself, and he had to wait until the end of the voyage. So it was not an infrequent occurrence, when the voyage was nearly over, for the crew to be run off the ship by brutal treatment, thus forfeiting to the owners the pay belonging to them.

"The Seamen's act allows a sailor to claim at any port one-half of the money he has earned. If he deserts, or quits his job without giving notice, he forfeits the pay due him, any effects he leaves behind, and he is subject to fines and imprisonment for numerous other offenses. While a wonderful advance for the sailor, there is not a laboring man ashore who would submit to the restrictions still placed upon the sailor.

"We have numerous unemployed, and if we wish to have American sailors the calling must be attractive, and to make it attractive the Government must remove the financial handicap now existing, by allowing to the shipowners the difference in pay and food between the American sailor and the foreigner. This is not a subsidy, for a subsidy is paid on account of the ship.

"We have had as an argument for protective tariff the benefit to the American workman, but the protection was on the product, and what the workman received was indirect. Here the benefit is direct to the sailor, and the machinery of the Government is already in operation to see that he gets it."

In the days of wooden ships, before the Civil War, American Clippers proudly sailed the seas to every port and clime, became famous in song and story, and by 1860 we were abreast of England in the carrying trade of the world—because we could build ships cheaper, build them faster, sail them faster, and, *paying to sailors the highest wages ever known in history*, we could beat the world in over-seas freight rates!

For a generation past we have been making and selling steel bridges, locomotives, mining machinery, machine tools, and now automobiles and motor trucks, in successful competition with all the world.

We have originated, and now standardized, the sky-scraper type of steel building—and a modern steamship is neither more nor less than a horizontal skyscraper building with its central power plant. Whether the ships be 100 feet long or 1000 feet long, we can build them cheaper, build them faster, and sail them faster than any other people on earth—and all the world now knows that we are certain to do it, wholesale!

Our compliments and congratulations to American ship builders—and a Happy New Year to the President of the United States who has pledged us a merchant marine, and to the Secretary of the Navy who has pledged us the perfected Fighting Navy now needed to protect the Panama Canal and the vast and growing over-seas commerce *of all the Americas!*

WE WANT FREEDOM OF THE SEAS—AND WE MEAN TO HAVE IT!

WE WANT BOTH PEACE AND PROSPERITY—AND WE MEAN TO PRESERVE AND ENJOY THEM BOTH!

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THE PRESSING NEED FOR A MERCHANT MARINE

By Stuart G. Gibboney

There can be no question in the minds of the American people that for the past forty years we have been negligent as a Nation in holding a supremacy in maritime trade. Now the opportunity has arisen again to obtain the mastery. The Administration has declared in favor of a plan that will recoup our power both in the pursuit of peaceful trade or an unexpected war.—THE EDITORS.

IT is impossible for anyone not in daily contact with the shipping needs of New York to realize the great demand for ships in which to transport the rapidly increasing exports from this port—a demand that is becoming more accentuated every day. It is estimated that more than 50,000 freight cars are crowding the terminals and tying up the lines of the various railroads running into New York. The harbor is blocked by lighters loaded down with merchandise awaiting ships into which to discharge their cargoes. Every available pier is crowded with goods awaiting export, and freight rates are advancing daily, at about the rate of ten per cent a week on some exports.

In the meantime the railroads have been forced by this congestion to reduce free storage time on export freight from thirty to fifteen days, and closely following this the Pennsylvania Railroad has placed an embargo on all export freight originating on all connecting lines and shipped to the New York District, whether for export, coastwise, or domestic consumption. This unprecedented action has been taken, according to the Company, "owing to the growing congestion of traffic in the vicinity of New York, *and in order, if possible, to avoid an impending absolute blockade.*" Thus it would appear that, although the traffic which reaches New York Harbor for export does not exceed twenty per cent of the total traffic of the port, the absolute congestion of this twenty per cent, owing to the want of ships to carry it, threatens to tie up the other eighty per cent of local domestic traffic and involuntarily to "blockade" the City of New York.

The surprising fact of the situation is that private capital, even with the great inducements offered to establish new ocean steamship lines, hangs back and will not take advantage of this wonderful opportunity. One is driven to the conclusion that Wall Street wishes either to rehabilitate the International Mercantile Marine and make good the well-watered stock of that corporation, or else is playing for a ship subsidy.

A practical illustration of the anomalous condition prevailing is furnished by the purchase of the steamship "Frederick" by some wide-awake steamship men in New York. This boat, built some thirty odd years ago, was bought the latter part of November, 1915, from the Merchants

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and Miners Transportation Company of Baltimore for $45,000. In less than a week it had been chartered for its first ocean voyage to Europe, and the freight received by the owners for this one trip has paid for the boat and yielded a handsome profit. The steamship "Caroline," which sailed from New York on December 4th, is another case in point. This boat, purchased in October, paid for itself out of the freight received for transporting its first cargo and its owners made a handsome profit besides. Innumerable examples of the same character could be cited; and yet a financial institution on Wall Street refused to finance these very transactions on the ground that the purchasers of the boats could not operate them profitably under the burdensome navigation laws of the United States.

Private capital having refused, except in such sporadic instances, to establish shipping lines and buy boats, the American exporter must either pay exorbitant freight rates, which will wipe out his profits, or else turn to the Government for assistance. Many there are who bitterly opposed the Ship Purchase Bill in the last Congress, who now sadly realize their mistake, for shipping rates have mounted higher and higher, until now they are almost past belief.

The Secretary of the Treasury in his report made on January 25th, 1915, to the Senate of the United States on foreign shipping rates prevailing at that time, stated that:

"Ocean freight rates on grain from New York to Rotterdam have been increased since the outbreak of the war 900 per cent; on flour 500 per cent; on cotton 700 per cent.

From New York to Liverpool the rates on the same commodities have increased from 300 to 500 per cent.

From Baltimore to European ports (excepting German) rates have been increased on grain 900 per cent; on flour 364 per cent; on cotton 614 per cent.

From Norfolk to Liverpool rates on grain have been increased from 157 to 200 per cent; on cotton 186 per cent.

From Norfolk to Rotterdam the rates on cotton have been increased 471 per cent; to Bremen the rates have increased on cotton 1,100 per cent, namely, from $1.25 per bale to $15 per bale.

From Savannah to Liverpool the rates have been increased on cotton 250 per cent; to Bremen the rates have been increased on cotton 900 per cent.

From Galveston to Liverpool the rates have been increased on grain 174 per cent; on cotton 361 per cent; to Bremen the rates have been increased on cotton 1,061 to 1,150 per cent."

And as time has gone on our exports have greatly increased, and the rates today are far higher than at the time the Secretary made his report.

The most remarkable convert to the proposal of Government assistance in the present ship famine is the *Westminster Gazette* of London. This influential English paper has at last reached the conclusion that it would be expedient for our Government to buy the German ships, now laid up in New York Harbor, so that the goods which are crowding our docks could be transported to England, where they are sorely needed. Thus even England has been forced to recognize that she can no longer carry in her hulls the goods which she must import from us, so much has her merchant shipping suffered from submarines and the great demand for naval auxiliaries and army transports.

Whatever may have been the opinion of the public a year ago as to a government controlled merchant marine, there can be no doubt now that the matter demands immediate action by Congress. The shipper can no longer be quieted by assurances that private capital will provide the ships. It has not provided them, and his situation is growing more desperate each day. Action is demanded, not promises, and Congress must pass some measure which will give him relief.

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Fortunately the National Administration is keenly alive to the crying need of the hour, and Mr. McAdoo, Secretary of the Treasury, in an able speech delivered last October, outlined a program which, if adopted by Congress, will go far toward relieving our pressing needs and laying the foundation for the establishment of an American Merchant Marine.

This proposal contemplates the building of merchant vessels of 500,000 gross tonnage to be used in time of peace as merchantmen and in time of war as naval auxiliaries. Thus the two needs of naval auxiliaries and of merchant vessels are supplied, and there can be no doubt that both are badly needed.

The United States at the beginning of the Spanish-American War was forced to pay exorbitant prices for inferior boats, owing to the pressing need for naval auxiliaries and army transports, and the great majority of these were afterwards sold practically as junk for almost nothing. The nation's demand for preparedness cannot overlook the essential naval auxiliaries, and it is peculiarly fortunate that these same boats in time of peace can be so advantageously used to develop our foreign trade, now reaching such large proportions.

It has been estimated that three hundred millions of dollars is now yearly paid by American exporters in ocean freight rates, and of this amount ninety per cent is paid to foreign boat owners. There can be no doubt that these government-controlled merchantmen could be operated profitably and come in for their proportionate share of this freight. For the argument that ships cannot be profitably operated under the American flag by reason of our navigation laws, is only a subterfuge put forward by those who seek to dip their hands into the Treasury and obtain a subsidy. The Pacific Mail and Steamship Company made this claim, but happily it has been exploded by the recent announcement that the newly organized American International Corporation, which is not in business for its health, has bought the remaining seven ships of the Pacific Company and will continue to operate them on the Pacific Ocean under the American flag.

That these ships may be operated under proper supervision and for the purpose of generally providing for the regulation of ocean shipping, the Secretary further advocated the creation of a Shipping Board; this Board to be composed of the Secretaries of the Navy and Commerce, and three civilian members to be selected by the President and confirmed by the Senate; and this Board to be authorized to establish without delay needed ocean steamship lines to be operated under Government control. And he specifically stated that *"we should not however establish regular steamship lines where sufficient and satisfactory service has been established by American companies operating ships under American registry."* In other words, shipping lines should be established by the Board only where there is no service, or else that service is so unsatisfactory as to demand a change, so that well established steamship lines which are now furnishing adequate service at proper rates need not fear harmful competition, if such a shipping bill should be enacted

Another proposal is that the Shipping Board shall have power to organize one or more corporations and to subscribe wholly or in part to the capital stock thereof. The advantages of this proposal are numerous: It would take the operation of steamship lines out of politics and insure their conduct along practical business lines, and at the same time it wou

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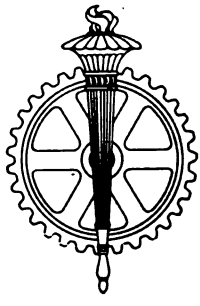
enable the Board to take stock in legitimate shipping enterprises to the mutual advantage of the Government and the operating line. And again, the power to lease or charter the government owned ships to responsible corporations or individuals could be availed of in a time like this to the greatest advantage.

The Secretary meets most effectively the argument of those who contend that shipping cannot flourish under American registry, by suggesting that the Shipping Board should be given power to reform our navigation rules and regulations and make such recommendations to Congress in this regard as may seem advisable. This meets the demands of our present situation most admirably, and would enable Congress to bring about much needed reforms in the interest of the economical operation of ships under American registry and at the same time protect the seamen and the lives of those who take passage on American ships.

That the Interstate Commerce Commission has accomplished many needed improvements in the interstate operation of carriers, no one can deny. No sensible carrier objects to regulation by so fair a commission, and just such regulation is needed to protect the shipper of goods on ocean going steamers. In fact, that is the imperative need of the present situation. The shipper must now pay the rate asked by the shipowner, no matter how exorbitant, or else his goods will remain on the docks or in the lighters of New York Harbor subject to heavy storage charges. The only way ocean rates can be fairly regulated as between shipper and shipowner is by a Board, having the same authority over ocean steamers as the Interstate Commerce now has over interstate carriers by land and water. And this power it is suggested shall be conferred on the Shipping Board, which will be in touch with both the needs of the shipper and shipowner.

Without giving further details such is the definite program of the National Administration to meet this intolerable condition. Its opponents have no counter-proposition to submit. Either the present condition must continue, or the program of the Administration must go through. For fifty years we have waited in vain for private capital to create an American Merchant Marine. Our deplorable lack of shipping will not permit any further delay. The Administration's program is sane and sensible, and all patriotic citizens, without regard to party, who wish to see the Stars and Stripes once more established upon the seas, should support it with all their energy.



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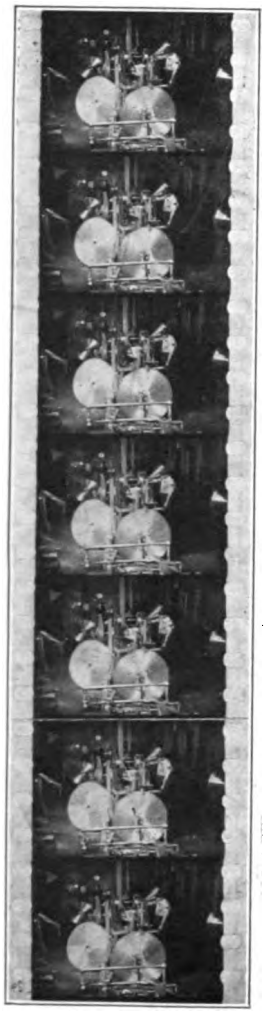
SELLING MACHINERY BY MOTION PICTURES

By John M. Torr

Keen competition in manufactured articles has brought about increasing difficulties in the sales of machinery. The manufacturer has learned by sad experience that it is sometimes impossible to convince his prospective customer of the superiority of his product over that of a rival firm without actual inspection. Size prevents him from carrying his machine to the customer, and distance will not permit the customer to go to the machine. In this dilemma the progressive manufacturer has joyfully hailed the advent of the motion picture film which enables him to display every step in the manufacture of the machine or article and every phase of its operation. We are indebted to the Dyer Film Company, Inc., the Educational Films Corporation, the Harold Ives Co., Inc., Thomas A. Edison, Inc., the Westinghouse Electric and Manufacturing Co., the National Tube Co., the Clyde Iron Works, and the Educational Films Corporation of America, for the accompanying illustrations.—THE EDITORS.



SHARPENING TEETH ON DISSTON SAWS

SOME years ago a maker of coke using the old-fashioned beehive ovens was approached by a representative of a modern process by-product oven. The coke maker was rather set in his ways and had little faith in what he termed "newfangled notions of those engineers and professor fellows."

The by-product process representative offered to treat the coke maker to a trip of inspection to a field where the new ovens were being used with great success. The manufacturer could not or would not take the time for the journey. He was naturally prejudiced against innovations and was antagonistic to the new process.

The oven salesman was of the tenacious type and tried all his methods to induce the prospect to take a little jaunt with him to a field where he could view the new ovens in operation. He sent him parcels of photographs, letters, and reams of literature, and was finally told by the boss to drop him from his list.

Some time later the salesman was in Chicago and was taken by a friend to see the machinery exhibit at the Land Show in the Coliseum. "You must see the exhibit of the Clyde Iron Works," the friend remarked.

"How can the Clyde Iron Works go to the expense of shipping skidders

GATHERING MACHINE IN A BINDERY

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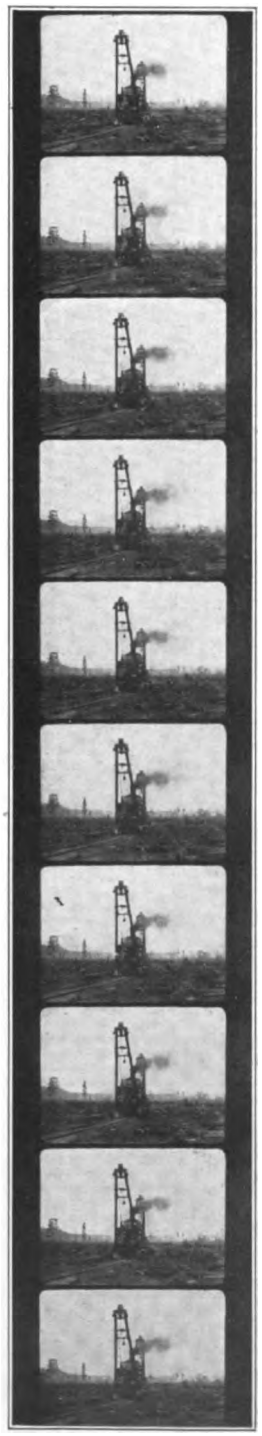


A CLYDE LOADER IN LOUISIANA

or loaders to such an exhibit?" the coke oven salesman asked in astonishment, and "how can they afford the expensive space to show them in?"

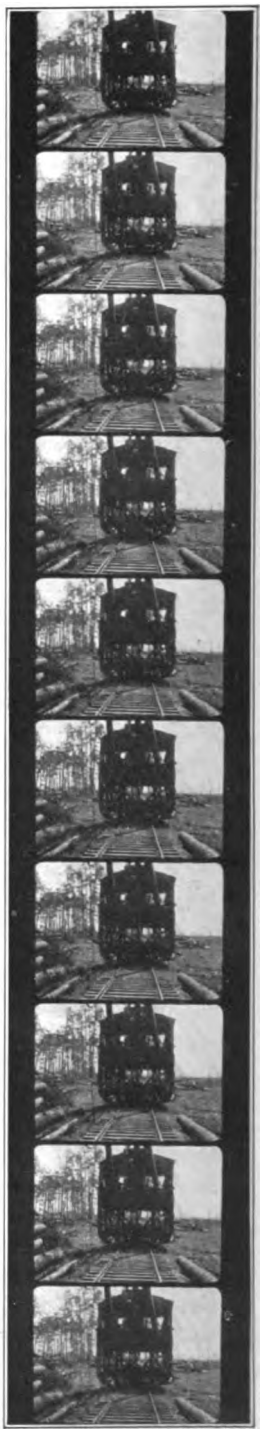
"Not only do they show the loader and skidder, but a complete operation," answered his companion.

The exhibit was a motion picture of a lumbering plant in Louisiana showing the loaders and skidders in actual operation and exhibiting every detail of their handling and efficiency. The oven salesman was not only startled but was so impressed that he promptly left the show to arrange for a motion picture of a coke-making plant showing his new process ovens in operation.

His boss was very skeptical and shied at the initial expense, so that the salesman had to work hard to be allowed to make the experiment. But, the picture was arranged for and showed the entire process from mine to finished article, loaded on cars, and the trainload of coke moving away over the rails to their final destination.

Then a small projecting machine was procured, and the salesman took the ovens to the prospect, who had no faith in "new-fangled notions." The pictures were quite impressive and resulted in the installation of new-process ovens to replace the old type. The entire cost of the picture was little more than would have been the expense of bringing one possible customer from a distance to view a working plant, and the pictures were available for use with their other prospective customers.

When the large forests of the West were tackled by the lumbering fraternity, it was found that the steepness of the grades and the size of the logs made it difficult to handle trains with direct-connected or rod locomotives. The makers of geared locomotives saw the opportunity, but the



A CLYDE LOADER IN LOUISIANA

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BORING MACHINE IN A LUMBER MILL

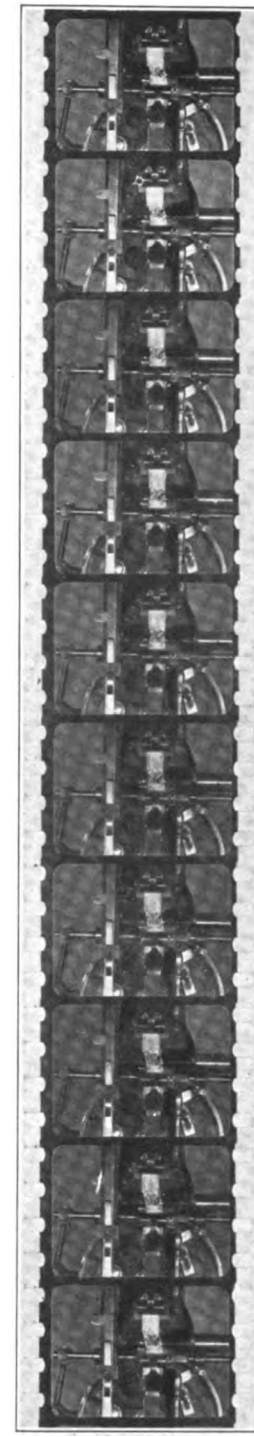
loggers were dubious about their use, and the makers of the direct drive engines naturally knocked the possibilities and abilities of the geared engine and claimed that the direct-connected engine could go anywhere the geared engine could and would pull as great a load and do it faster.

Then along came a young fellow who was selling geared locomotives as agent for the maker. He was neither an engineer nor logger. He had a sound knowledge of railroads and equipment and was a clever salesman. He had perfect faith in the locomotive he was selling and he knew the geared engine would climb the stiffest grades and pull a load after it. He arranged to put in an engine on trial on one of the steepest and most notoriously difficult pieces of logging road.

He had motion pictures made of the locomotive "walking" up this grade with a string of loaded trucks behind it. He showed it coming down in the same manner. Grades and curves and bad pieces of road were all brought out in the picture, and through and over all the geared locomotive marched along with its train of trucks.

These pictures were exhibited at loggers' conventions and meetings of equipment men and supply houses. They were shown by salesmen with small projectors and the geared locomotive found its place as a necessisty on heavy grades and is there to stay.

Machinery, either locomotives, trucks, or any kind of donkey, yarder, skidder, loader, or other piece of equipment, for use in the forests of the Pacific Coast must be of heavy type and, consequently, it is out of the question to send samples. The motion picture, therefore, has filled a great vacancy in showing and educating the prospective buyer on the action, appearance, and value of the contemplated installation.



MACHINE TESTING THE STRENGTH OF FABRICS

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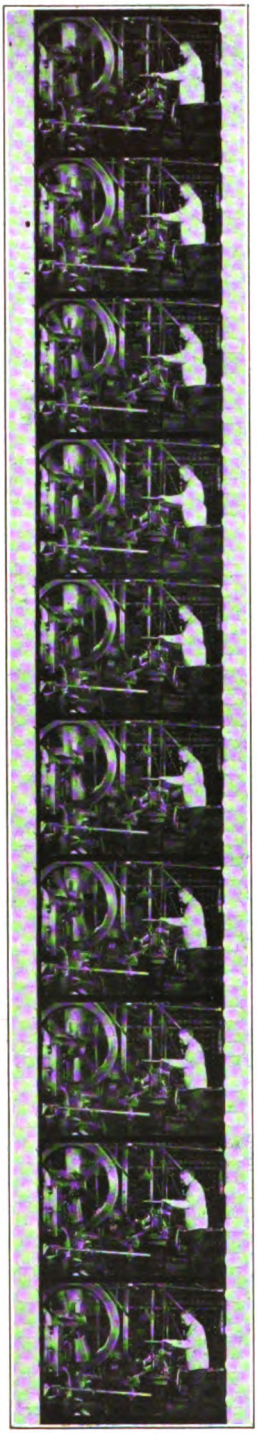

CUTTING STEEL BARS, IN THE PLANT OF THE L. S. STARRETT CO.

An owner of water-front, dock, and warehouse property could not handle the goods with sufficient speed and cheapness and went from one maker of equipment to another inspecting and trying what they had to offer. There was nothing in the way of equipment in his own or the near-by cities that helped his problem toward a solution.

He then made a contract with a local stevedoring firm to do the work, but the stevedores could not make much money on the contract. The floors were inclined and made heavy trucking, so that the men could not work as rapidly as on the level floors and docks; but as the floors were built on piles, heavy expenditure would be required for construction.

The representative of a modern equipment house came along and endeavored to sell the owner of the property some conveying machinery. The latter had inspected the catalogs of the local houses and saw no such articles in them and was doubtful about their ability to do the things the salesman claimed for them. He would not give the salesman any encouragement, and wound up by telling him that it did not interest him at present anyway, as he had let the work on time contract to the stevedoring firm.

The salesman promptly called on the stevedores. Here he found an old-time sea captain who believed in "man" power and was not in favor of any methods he had not seen. It was impossible for him to leave the job for a visit to the salesman's plant to see the conveyors and transmission machinery in operation.

Again the motion picture was brought into action, and a reel made showing different kinds of transmission machinery in actual work on the kind of packages the stevedore had to handle in his place. The stevedores

GRINDING COMBINATION SQUARE STOCK, THE L. S. STARRETT CO.

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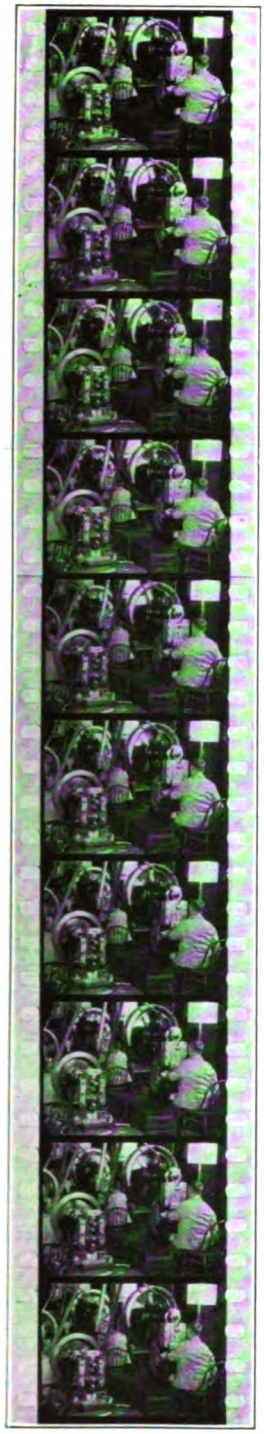

PUNCH PRESS ROOM OF THE L. S. STARRETT CO.

were so surprised at the results, both in cost saving and time saving, that they decided to install them in all the places they were operating in.

They leased all the dock and warehouse property they could get for long terms of years. They made long-lived stevedoring and handling contracts at reductions from the going prices. Then they installed the machinery. They are now rich and independent men, firm believers in the motion pictures and now use them in teaching efficiency to their crews.

It is a remarkable thing that the buyer of machinery and equipment should be so opposed to new methods and makes. Strange machines promptly rouse his ire; he refuses to admit the possibility of their doing the work. He does not seem willing to give the salesman a fair hearing and will rarely go to see the new equipment in operation. This is human nature—it is all nature. The unknown and strange is always repellant and causes the dander to rise in a man as a strange scent causes the hair to lift on the back of a terrier.

After we have seen and inspected a thing or an animal or person, we grow to tolerate them. A little further visual contact causes familiarity and from there to the willingness to utilize is only a short step. The motion picture is today the most potential selling power in the field of machinery, equipment, and process sales. It combines and consolidates psychology, speech, and suggestion into the battering ram of conviction and action.

A city located on a large river was having difficulty in handling the fires along the water front. A big blaze caused by the burning of a number of Standard Oil storage tanks caused heavy losses to the insurance companies. The underwriters then lifted the rates so high that there was a ter-

DEMONSTRATING WESTINGHOUSE APPLIANCES

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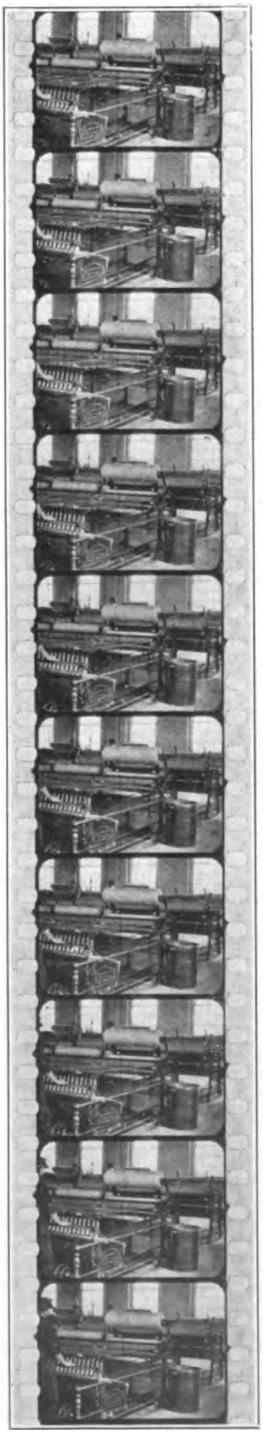


SPINNING MACHINE IN WOOLEN MILL

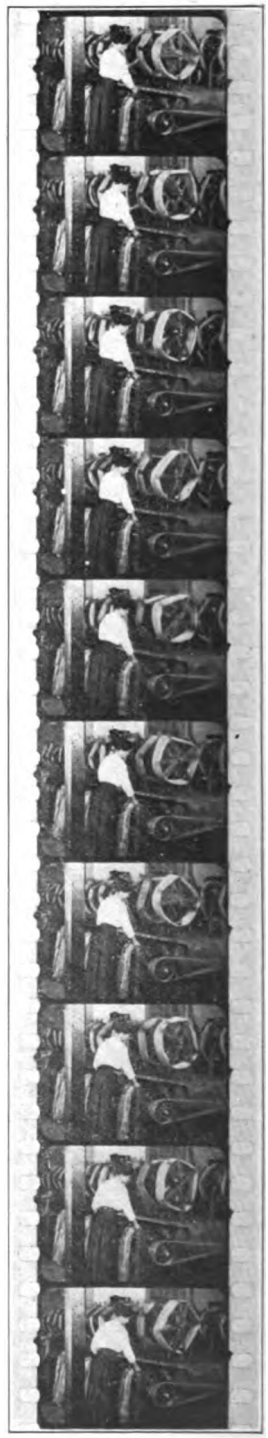
rible howl from the property owners for fire protection and the consequent return of the insurance rates to the old level. All kinds of politics and calumniations were injected into the discussion, until finally a fire boat was suggested as a solution.

The mayor proposed that some of the city fathers visit places where such boats were used, and see if they could agree on the proper type of steamer for the town. The opposition papers promptly cried "junket" and "waste of taxpayer's money." There was no reason, said they, why the water front property should be made the excuse for a political junket. The mayor was villified, and, in consequence, perplexed. So was the fire chief. No one wanted to contract for a fire boat without seeing one and no inspection party could be agreed on.

It was then that the representative of a fire-boat builder stepped in with motion pictures, showing fire boats of all makes and types doing all sort of feats. There were reels showing the fire boats of various cities, and of every type, size, draft, and price. The pictures were shown at various picture houses in the city, at private places, and political gatherings. That city now owns several fire boats and all were built by the firm that showed the motion pictures.

There are certain seasons of the year when some classes of machinery cannot be shown in actual operation. The motion picture knows no seasons, language, or country—it is a universal medium of demonstration and communication.

If an American maker of harvesting machinery desires to show his machines in operation to the prospective buyer in some other country, he is enabled through the medium of the motion picture to overcome the difficulties of language and transportation. In addition, the motion picture oblit-



SCENE IN NEW ENGLAND WOOLEN MILL

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HOLT CATERPILLARS ON A GANG PLOW

erates the seasons and makes it just as feasible to make the demonstration in the winter as the summer, in spring as well as at harvest time. Whether planter or reaper, it can be shown in spring or autumn.

The pictures of the Caterpillar, made by the Holt Manufacturing Company and now used all over the world, are a remarkable example of what can be done in the way of demonstrating the working of machinery and equipment. The Caterpillar field tractor is a powerful force in the present war and is used to pull the heavy siege guns. It replaces other motive power and moves over the most irrregular and uneven ground. The Caterpillar replaces the big "jerk-line" teams in pulling harvesting machinery over the great grain fields of the world. The road tractor is also exceedingly useful in transportation. The motion picture of the tractor in operation is a perfect exposition of the potentialities of the screen as a medium for showing wares.

It is easy to grasp and appreciate the possibilities of the motion picture in the selling of machinery and equipment. It has been used with known success in this field for several years, and the manufacturer is behind the times in his selling methods who does not make use of the screen.

From very small enterprises many plants have been built up to great proportions. The owners frequently have grown with them. Many of these men have seldom gone out of their own city and possibly never left their own state; they are not fully informed about the great march of events in the field of machinery improvement.

When the maker of a new type of machine asks a salesman to sell a man who has never seen such a piece of equipment and who lacks the imagi-

CATERPILLARS IN A MARSH AND ON A HILL

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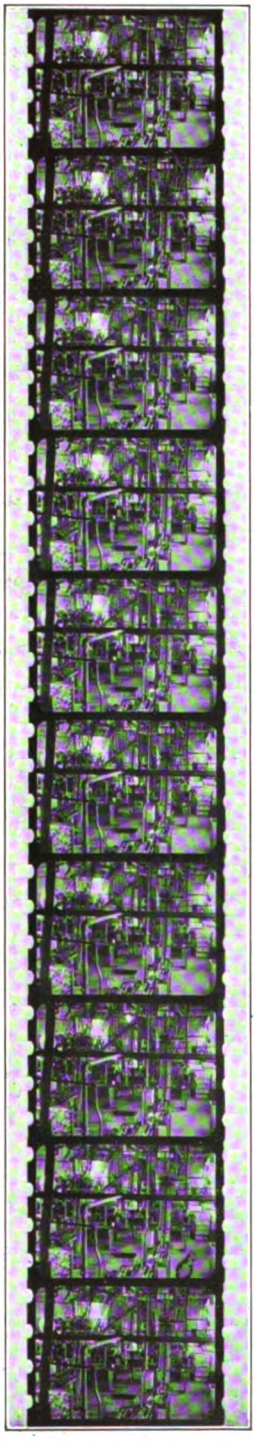

GENERAL VIEW OF BORDEN CONDENSED MILK COMPANY FACTORY

nation or the desire to picture it in his mind as it would be when installed in his plant, that salesman has been handed a big task.

In such work the motion picture is invaluable. It furnishes the salesman a complete working model, actual size, of the machine or piece of equipment as a sample. The eye of the prospect grasps it quickly and photographs it on his brain. With such aid the balance of the work is fairly simple.

A printer who owns a large plant in an inland city recently called on the writer. He had bought some new presses and had made contracts for binding and other parts of the work he was not equipped to handle to advantage. He had spent a large sum of money, but he did not have a complete plant.

In the course of his visit, a large and very modern printing and publishing plant in Philadelphia was inspected. The printer was positively astounded to see so much machinery that he was not familiar with, and which he could have installed at a great profit in cost saving. In a general way, he had heard of such equipment but was doubtful as to its practical success. It is certain that motion pictures of the new machinery in action would have sold it to this man for he deeply regretted that he had already made his contracts for the next few years.

To look over the names of manufacturers of machinery and equipment who use motion pictures in their advertising and selling campaigns, is significant. We find the International Harvester Company, Holt Manufacturing Company, Westinghouse Electric Company, Clyde Iron Works, American Steel & Wire Company, National Tube Company, duPont de Nemours Powder Company, and others.

The engineer has overlooked the power of the motion picture as a sup-

STAMPING MACHINE CUTTING TOPS FOR CONDENSED MILK CANS

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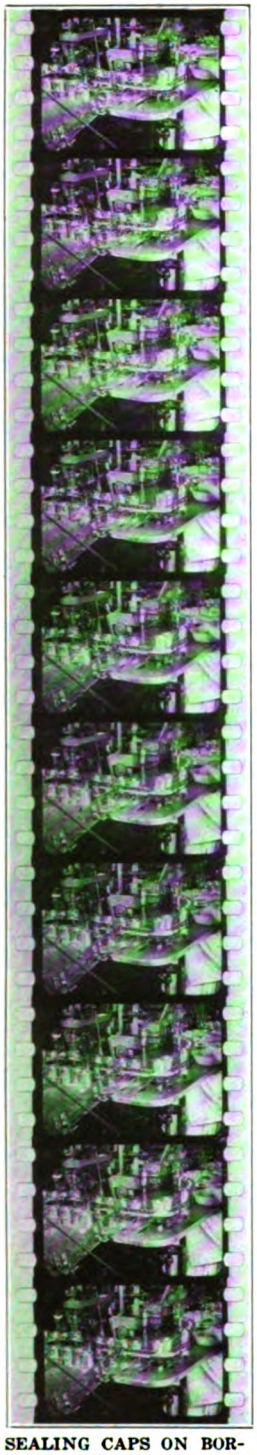


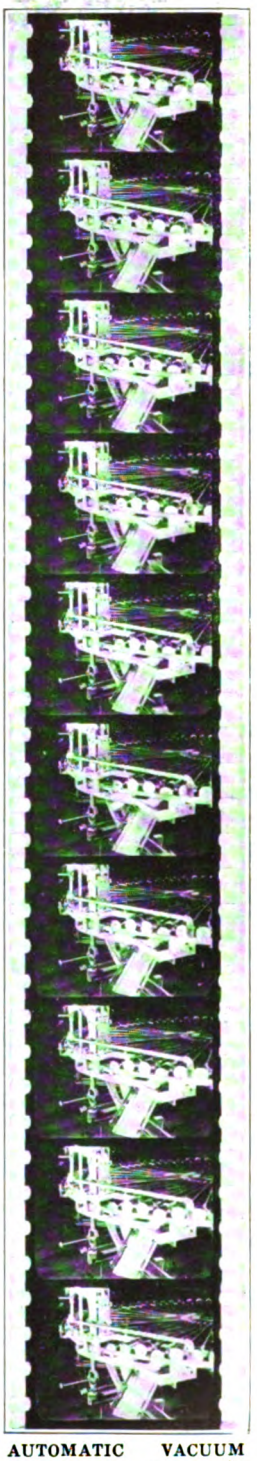
SEALING CAPS ON BORDEN CONDENSED MILK CANS

port and witness to the written report. Often the mission of a report fails, no matter how valuable and well made the paper may be, through the inability of the bankers or financiers to grasp its import or to visualize the properties it describes.

A large manufacturer was in financial difficulties. He wanted to borrow several million dollars in the form of a bond issue and applied to several bankers and bond houses. He had exhaustive reports on his property which included lands, industrial railroads, and mills. The property was so vast of its kind that the owner found it practically impossible to interest any banker or broker. Finally he was sent to a broker who understood the business. The reports were carefully examined and a few days spent in working out a plan and ascertaining the safe amount of money that was needed.

A motion picture of the plant and operations was suggested by the broker. The owner of the plants was astounded at the idea and declared it nonsense and a waste of money. However, it was finally arranged with misgiving and grumbling and the pictures made and duly finished. A meeting of a few bankers was then arranged for and the pictures exhibited. The loan was underwritten before the men left the room, and the details were later worked out by engineers and lawyers.

The engineer often finds part of his report doubted or questioned. This is particularly the case where it treats of an unknown country of vast possibilities or of very high figures. If the financiers are not familiar with the region or the industry treated in the report, they often doubt anything that is much better than the "averages" they find in reading. In such cases, the motion picture can be used to perfect advantage in driving home the



AUTOMATIC VACUUM WHEEL FOR BORDEN'S CONDENSED MILK CO.

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ETCHING PROCESS AT ROYAL ELECTROTYPE CO.

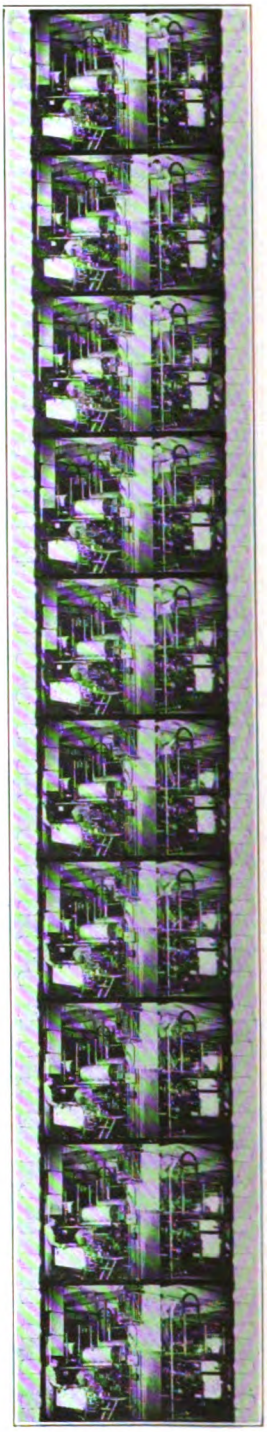
argument of the report and in proving the truth of the written word.

A coal property recently came on the market for sale. The mines had not been very successful and there was doubt as to the nature of the underground work. The property was owned by a careless operator who refused to employ an engineer and allowed the property to run down. He maintained that he knew as much as any mining engineer. The result was that it came to a point where his creditors were forcing him so hard he decided to sell.

The broker who had the handling of the property quickly realized he could not make the sale on an ordinary report. He sent three well-known men to examine the property and report on it. Their documents could not overcome the prejudice created by the years of slovenly work of the owner. The broker then found that motion pictures could be made underground. He had a reel made of the underground and surface workings, showing the entire operation in complete detail, and the nature of the floors, walls, ceilings, and equipment. The pictures backed up the reports fully.

With the reports, supported by the motion pictures, the broker sold the property and got an advance over the original asking price sufficient to cover the cost of making the pictures and leave a nice balance. The makers of coal-mining and handling machinery could follow this broker's example to their great profit.

The owner of a property, carrying large deposits of raw material and with very cheap fuel adjacent, was confining his efforts exclusively to the manufacture of lime. He was, for him, doing very well, because he had built the business from one small kiln to a capacity of three thousand barrels a day. His machinery and equip-



CURTIS PUBLISHING COMPANY'S PRESS ROOM

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COOLING PIPE, THE NATIONAL TUBE CO.

ment were very crude and antiquated, but the low cost of raw materials enabled him to compete profitably with modern plants.

A salesman and an engineer were endeavoring to persuade him to put in new machinery for handling, to modernize the lime plant, and to install a cement-making plant. The salesman eventually gave up in disgust and stopped visiting the place. The engineer was full of imagination as well as determination. He had pictured in his mind an enormous lime and cement plant of the most modern type on that site and he was going to build it. To be absolutely certain of his position, he spent some months in the region examining, testing, and calculating. He made pictures, blueprints, and drawings, and a lay-out of the new plants as he contemplated they would be when fully installed. With the completed figures he again attacked the owner and spent several days with him. But the latter was afraid to venture, claiming that he was making money and "did not care to experiment with anything he had not seen in operation."

Then the imaginative engineer hit on a great idea. He invested in a motion picture of a modern cement plant and an up-to-date lime-making plant, and showed them to the owner of the property. A close and continued study of the pictures was so convincing that the engineer was given an interest in the property and asked to go ahead with the new plant.

It was hard work, but the engineer had staying power; and today a splendid and modern plant, making lime, cement, and other products crowns the site he selected originally in his imagination and stands as a monument to his courage and ability. Motion pictures were used all along the line by this engineer, from the time when he so convinced the owner that

INSPECTING PIPE, THE NATIONAL TUBE CO.

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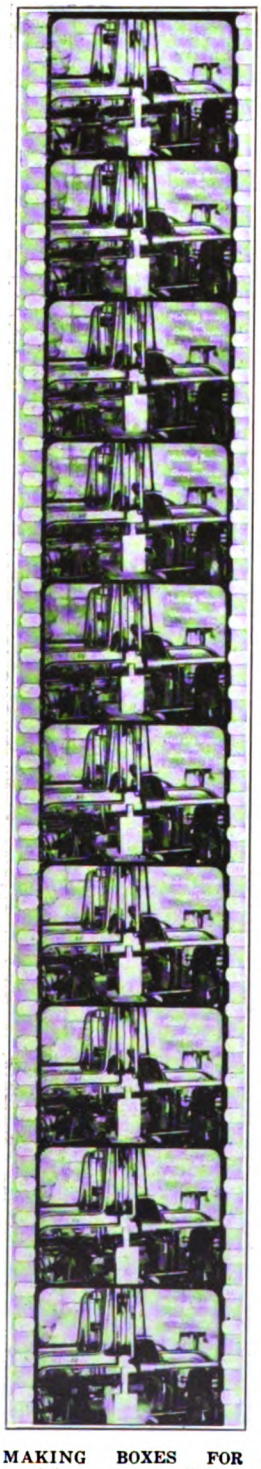


MAKING BOXES FOR "GRAPE NUTS"

he gave him an interest to the time when he convinced the bankers to loan the necessary money in the form of a long time bond issue.

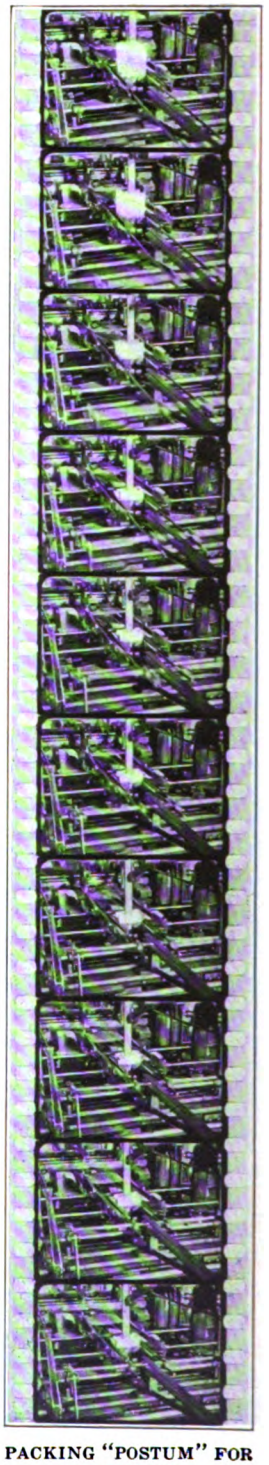
If the salesman for the equipment house had had imagination, he might have grasped the motion-picture idea and used it to present his plans to the lime maker, and could undoubtedly have sold him; but lacking just that imagination, another maker of equipment installed the new plants. Today, the salesman is still selling goods, while the engineer is independently wealthy.

When the maker of machinery, plants, and equipment asks the average person to look over blue prints and written descriptions and thus form a final conclusion as to the worth of his products, he usually finds himself in difficulty.

It is mentally impossible for the general run of people to visualize or image a plant or machine in working and running form from an inspection of drawings and written descriptions, no matter how graphic and conclusive they may be.

Machines are generally too large to be shipped around for inspection by the prospective customer; it is physically impossible to ship plants and processes; and, very frequently the prospect cannot arrange to visit a place where a machine or a method can be inspected.

The modern portable motion picture projector is light in weight, small in size, and can be easily operated. Films can be shown any place at any time and are the ideal method of demonstrating the salesmen's wares. Some manufacturers are making a specialty of these portable projectors, which may be tapped to the lighting circuit and used in the office of the prospect, with a blank wall as the screen.



PACKING "POSTUM" FOR SHIPMENT

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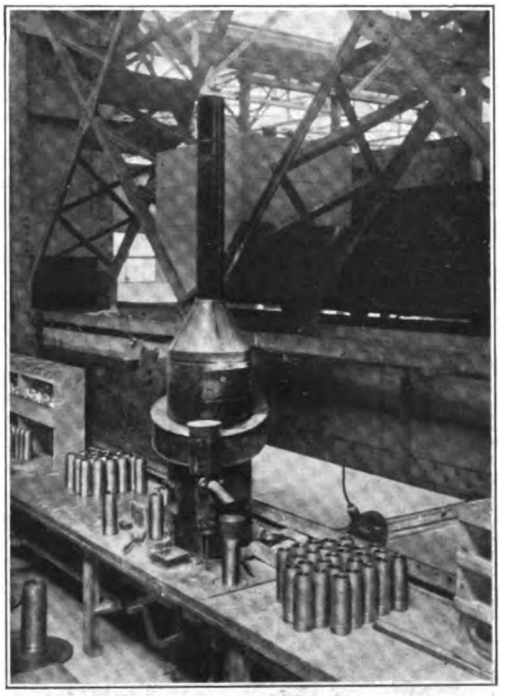
MUNITIONS MAKING FOR SMALL MANUFACTURERS

By Gerardus Harrisson

There has been a feeling among the smaller manufacturing shops throughout the country that contracts for munitions of war would involve too great an initial outlay for special machinery to warrant their acceptance. Mr. Harrisson finds that that impression is not justified, and describes the work that can be profitably undertaken without the need of any great additional investment.—THE EDITORS.

PROPOSITIONS for taking up the manufacture of war munitions, where war orders or munition machinery have not been their regular lines of manufacture, have come before the manager and have been discussed by the Board of Directors of nearly every plant in the country. Hundreds of plants, running on part time during poor business periods have been eagerly looking for some means of increasing their profits and keeping their men employed, even if only to tide them over the present unrest; and few solutions present themselves so favorably at such a crisis as the manufacture of munitions, particularly the shrapnel and high explosive shells. When the present war started, and the market for munitions opened, only those larger interests with considerable capital, machinery, and expert engineers, dared venture to undertake contracts; since then conditions have radically changed until now every sort and kind of business enterprise has taken up the work successfully; even a company whose regular business has been the manufacture of bread has gone into munitions making.

For the majority of manufacturers in this country, munition manufacture presents an entirely new field to their specialized knowledge and general experience. To undertake the making of shells requires dealing with quantities of production running up into the thousands per week and hundreds of thousands per contract, and for a concern which has been turning out, say, 5,000 to 10,000 gas engines a year, the idea of 50,000 to 100,000 shell forgings per month



BULLET AND RESIN FILLING ARRANGEMENT FOR LOADING SHRAPNEL

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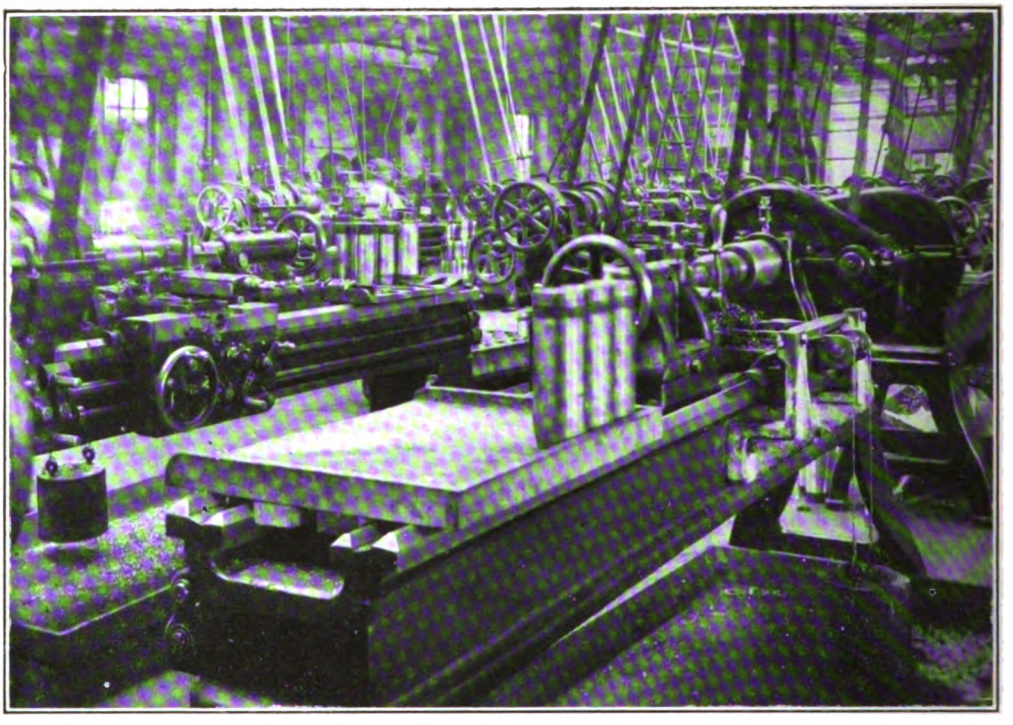
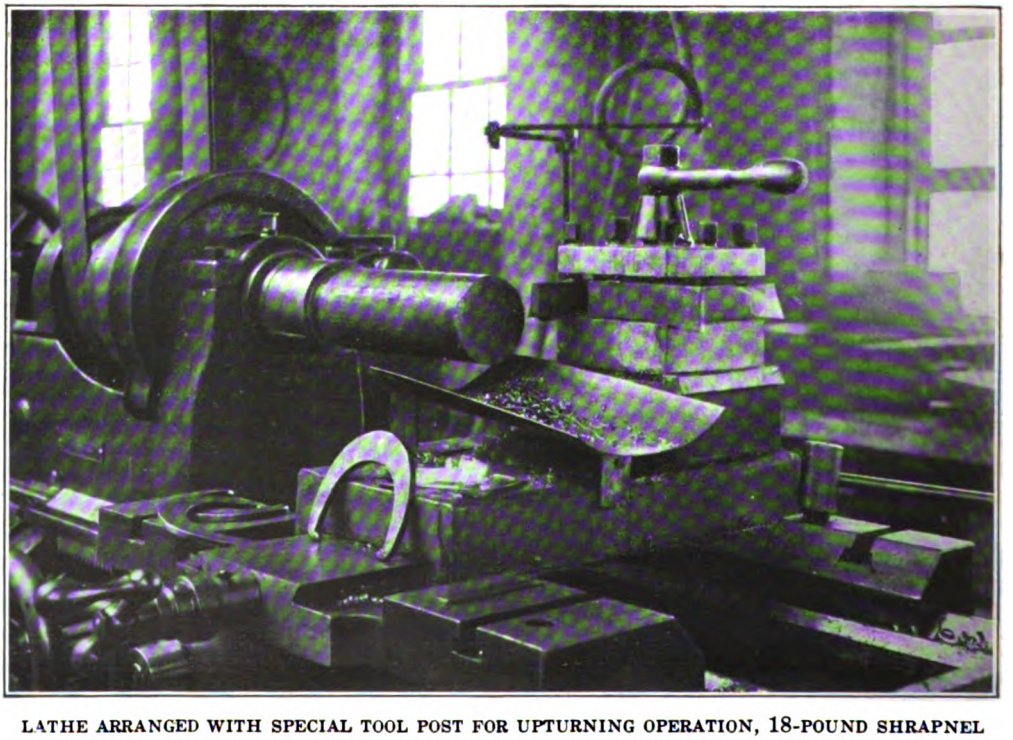


GENERAL VIEW OF A MACHINE SHOP MAKING 18-POUND SHRAPNEL. LATHES ON FINISHED TURNING OPERATIONS IN THE FOREGROUND



LATHE ARRANGED WITH SPECIAL TOOL POST FOR UPTURNING OPERATION, 18-POUND SHRAPNEL

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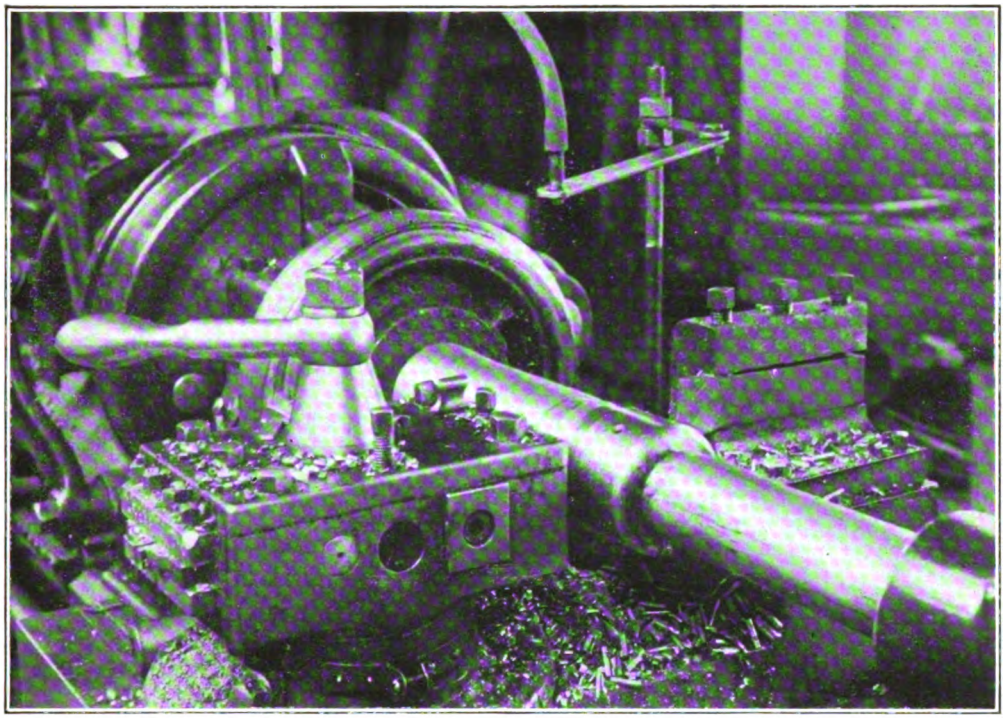
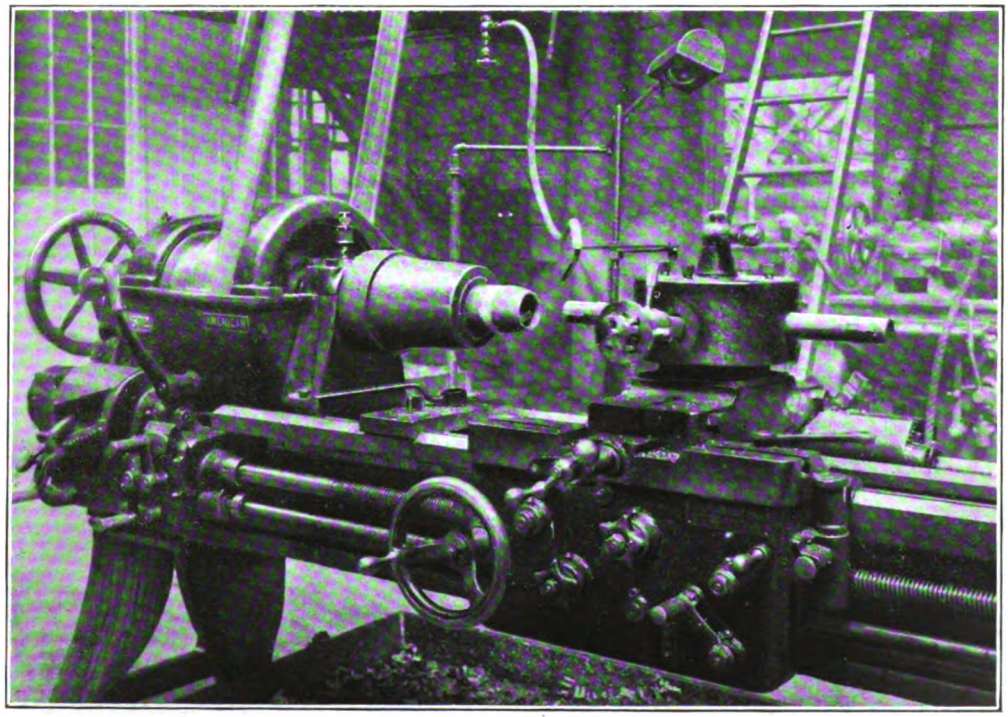


GROOVING AND WAVE-RIBBING ON ENGINE LATHE WITH SPECIAL ATTACHMENTS



BORING AND TAPPING THE NOSE OF 18-POUND SHRAPNEL

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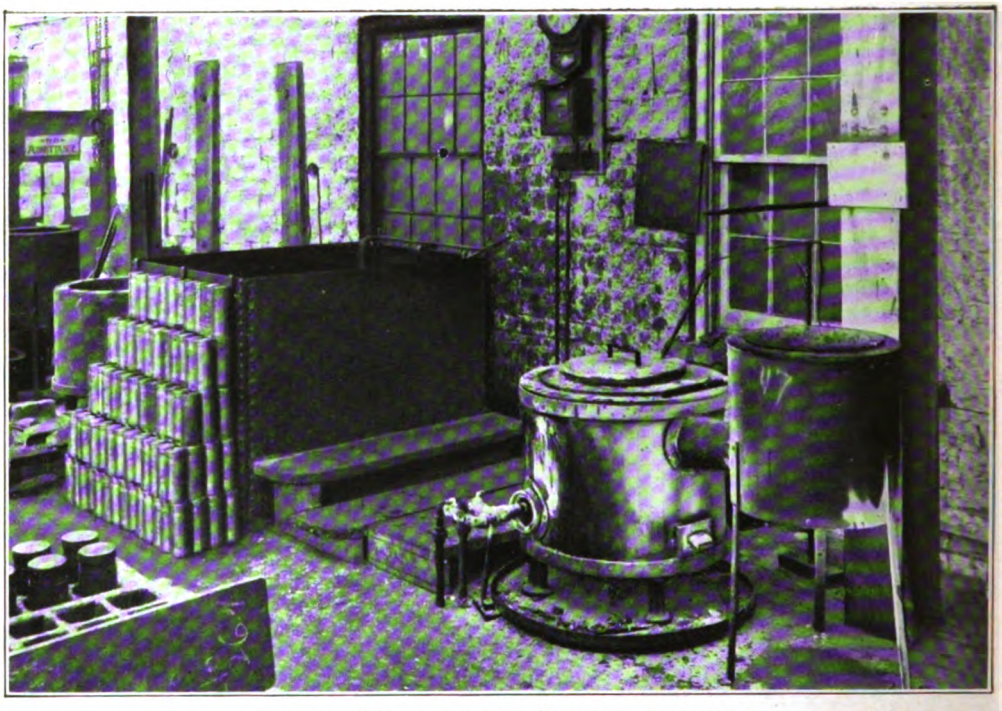

HEAT TREATING UNIT FOR 18-POUND SHRAPNEL

ASSEMBLING 18-POUND SHRAPNEL. FILLING WITH BULLETS AND RESIN IN THE FOREGROUND

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seems almost an impossibility. This figure is, however, far from the high water mark of production for many small manufacturers. There is practically no other article, so specialized in character, demanded in such enormous quantities, with such a certain and ready market as munitions at this present moment.

How few machines there are that can show a net profit of at least fifty cents each and can be turned out at the rate of over two a minute by a force of less than thirty men; but such has been easily accomplished by some novice plants manufacturing shells. There are so many different processes and operations in shell manufacture that almost any plant can find some part to do if not the whole. Just the opportunity for an organization running low, with idle machines and hands but no orders; or the busy plant with a little capital to invest and space to turn over to the making of good profits, and getting their share of the munitions plum.

With all of these bright aspects, however, the field cannot be entered rashly and without careful preparation. The largest part of the work involved comes before even one shell is turned over, and nowhere can we apply the adage "a good beginning makes a good ending," to better advantage. Considerable study along new lines is necessary for many, and owing to the wide extent and competitive nature of the business, information, reliable to be valuable, is quite scarce, in spite of the "opening up" policies of the technical press.

Inquiries have come in to the writer asking, "Where can we go to see a plant in operation manufacturing munitions?" The answer has necessarily been, "Nowhere that I know of." What business man, after spending weeks of study in developing his business, wishes an outsider and competitor to visit him and even unconsciously appropriate the fruits of his toil? The shell business is new, and in many cases no two plants perform the same operations in the same manner; very little is at all standardized, and each enterprise is practically a new invention. Some plants have been highly enough organized with their own corps of engineers, superintendents, and artisans to solve the new problems themselves; others have secured the services of consulting engineers familiar with the requirements of the business; still others have bought off men from successfully operating plants and trusted to knowledge so obtained to start them right.

Often the internal reorganization and equipment of a plant present the simplest problems to be solved. Local conditions, existing layout and space conditions, machinery on hand, help available, the prevailing labor wage and power accessible largely regulate the class of work most suitable to undertake and the best method of routing material. Finding a contract not sucked dry by numerous brokerage commissions, securing deliveries of steel from the over-rushed steel mills, obtaining new machinery from the over-taxed machine and tool manufacturers, and determining just what equipment the capital investment warrants, form the chief nuts to be cracked. In this work the chief asset a plant can have is a superintendent, manager, or engineer who can work out new ways for doing things in order to utilize in the best manner the means at hand and make the regular business operations and machinery serve for portions of the new work with the fewest number of changes and the least amount of instruction.

This discussion warrants little

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space to the subject of small ammunition, such as cartridges, or large ammunition, such as shells over six inches in diameter. These fields, because of their specialized character, are practically closed to the small manufacturer. They require too much help and involve too much investment, in the manufacture of cartridges; or, in the manufacture of shells over six inches, they require such heavy-duty machinery that few small plants are properly equipped to undertake the work or would find the investment in new machinery warrantable for future use. Briefly, the investment required to manufacture cartridges, exclusive of special buildings, would be about $90,000 for a machinery equipment capable of turning out 7000 cartridges per hour. The cost of manufacturing, on large contracts of a hundred million or more, has in some instances been brought down to about $23 per thousand, and some contracts have been signed on the basis of $27.50 to $31 per thousand.* Female help is extensively employed; elaborate tool rooms must be furnished for the maintenance of the special tools and dies; and the manufacture is subdivided into a number of different branches which require special and isolated buildings and equipment, such as brass foundry, rolling and drawing plant, bullet plant, plant for making the fulminate caps, and loading building, besides several assembling, packing and shipping departments. Too large a proposition to attempt except upon a permanent basis or one of large magnitude and with irrevocable contracts. The so-called 8-inch, 9-inch, and 12-inch shell contracts will probably be chiefly taken up by large steel plants where the heavy machinery and experience are at hand or where large enough contracts can be handled to warrant the requisite investment.

For the reasons above given, eliminating the small and extra large munitions, the shells ranging from 3.3 inches, or 18 pounds, to 6 inches, or 100 pounds, both shrapnel and high explosive, present the best opportunity to the small manufacturer.

In the manufacture of these shells two distinct operations present themselves: the one, the forging operation; the other, the machining and finishing operation. Each is completely separated from the other, and each may best be considered by itself.

SHELL FORGINGS

All of the shells, with the exception of the 18-pound high explosive which is drilled, may be forged from slugs. These slugs of solid steel are made according to specified composition. Some are obtained in square or round bars from the mill and cut off to the desired length, either by high-duty, generally double-tool, cutting-off machines, or by large cold saws; others are obtained already cut to the length required. The slugs, separated into "heats" for purposes of inspection, are fed into large furnaces, generally of the oil-burning type, where they are heated to about 2100 degrees Fahr. From the furnace they go to large hydraulic piercing presses, are then reheated, passed through drawing presses, annealed, inspected, and either turned over to the machining department or shipped to some concern which handles the machining process alone. This is the general method of procedure. It has, however, many variations dependent upon local conditions. In some cases it is possible to

* Since the foregoing was written the prices of raw material have advanced by leaps and bounds, and now $30 to $32 per thousand is the lowest cost which may be safely estimated.—EDITOR.

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perform both the piercing and drawing in one operation on the same press. Often, however, the cutting down of the percentage of waste warrants the extra labor and expense of two presses. Some concerns prefer the square to the round slugs and claim that there is less strain upon the dies when piercing such a shape as compared with the round.

This, which sounds so simple, involves considerable planning before the furnaces even are ready for the slugs; but the forging end presents one of the most alluring portions of shell manufacture. Comparatively little space is required, only a small force of men, from 10 to 15 per shift on two operation work, and the only skilled mechanics needed are those few in the tool room for maintaining dies and plungers. Ordinary labor may be broken in to operate the cold saws and cutting-off machines.

The fuel-oil and blast-piping systems required for the furnaces, as well as the proper design of the furnaces themselves, and the hydraulic pumps, accumulators, and presses all require experienced designers and planners. The hydraulic pressure generally used is 1500 pounds per square inch furnished by either steam or electrically driven pumps. In making these shells all presses may be of the vertical type.

In our discussion, buildings, and at least a source of power or a small power plant of from 150 to 200 horse power capacity are assumed to exist or to be available. In many cases, new buildings have been warranted, their size and cost being governed by their permanency and adaptability for future use. Structures have been designed and erected ranging all the way from small corrugated iron sheds costing but a few thousand dollars, to large buildings of over 20,000 to 40,000 square feet floor space and equipped with traveling cranes and all classes of time and labor saving devices.

The handling of material forms a very important consideration, especially in the case of the 60-pound and 100-pound shells. For the smaller shells, provided the machinery is well grouped, hand labor is generally sufficient, except when unloading bar steel from the cars or in feeding the cutting off machines; for these purposes, an overhead traveling crane or at least a jib crane is advisable. In some cases the cold saws are fed by inclined platforms, but cranes are generally used. For the larger shells, overhead trolley systems or roller chutes are used. Special devices for loading and removing the shells from the furnaces and presses all may be developed very easily by any energetic and resourceful engineer or superintendent.

The questions of vital interest to the concern contemplating entering this business are "How much money will we make?" and, "How much money will it be necessary to invest?"

The first question is impossible to answer even roughly without knowing the size of the shell contract available, the existing plant equipment, the experience at hand, the personnel, and the business methods of the organization itself. Many instances are known to the writer where the net profits amounted to from 40 to 75 per cent of the contract price.

The second question, "How much money will it be necessary to invest?" may be more closely answered by assuming a few general conditions. Exclusive of buildings, costing from $6,000 upwards, power plant, and material, which may be closely determined from the current market price, the required investment for installing the necessary forging ma-

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chinery, including pumps, accumulators, presses, furnaces and one complete set of dies, jigs, and fixtures, will run about as follows:

For the 3.3-inch or 18-pound shrapnel, $22,000 will be adequate for a capacity of 125 forgings per hour.

For the 4.5-inch or 35-pound shell, $18,000 will be adequate for a capacity of 80 forgings per hour.

For the 5-inch or 60-pound shell, $25,000 will be sufficient for a capacity of 40 forgings per hour.

For the 6-inch or 100-pound shell, $40,000 will be sufficient for a capacity of 30 forgings per hour.

These figures are based on minimum outlay, but they are conservative enough to allow some margin for bonus on delivery of machinery and ordinary expenses in getting started. Naturally local conditions will cause marked variations in these amounts.

The warranted investment should be governed largely by the size of contract available and the desired working capacity of the plant. Many small manufacturers, in the early stages of the business, entered the field in an experimenting frame of mind. Small contracts were obtained and cheap, light machinery purchased, the intention being to become acquainted with the proposition on a small scale first, then later, after gaining experience, to undertake larger contracts. Unfortunately for many of them, when their small contract was completed, their machinery was ready to scrap, slim profits were found in the treasury, and most of their experience consisted in learning to repair broken-down machines. By that time the big contracts which they had counted upon were not so easily obtained.

For the manufacturer unfamiliar with the market values of some of the materials and the general items of expense and how they are made up, the following estimate based upon general approximations shows the average conditions met in the manufacture of 3-inch Russian shrapnel and forgings:

Material at 2½c per lb	$.28
Productive labor—cutting off operation	.01
Burden on same at 100 per cent	.01
Delivered to furnace	.30
Productive labor—forging	.05
Burden on same at 200 per cent	.10
Losses at 2 per cent	.01
Total Cost	.46
Approximate contract price	.75
Profit	$.29
Capacity per hour	125
Profit per hour	$36.25
Machinery investment required, Estimated	$22,000

Burden is considered as including wear and tear on machinery, fuel, power, replenishing and repairing dies and plungers. Losses provide for discarded shells and also those required for making special tests.

Shell making must be entered into with a determination to make profits in the long run and not through saving pennies at the start by installing cheap equipment. Success will be gained through the constantly increasing capacity of a well organized plant, with the machinery running smoothly and reliably, and the men working with vim and enthusiasm, pocketing five or six dollars a day instead of the two dollars and a half to which they were probably accustomed. In one company with which the writer is acquainted the men make over $5 a day and the company writes off over $1,000 net profit every 24 hours from forgings alone.

Even though a manufacturer desires to undertake only the forging end of the business, it is almost always worth while to develop a small machining and finishing department in connection therewith. A small contract or sub-contract may be obtained that will recover what would otherwise be wasted and lost from

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rejected shells. Many forgings are often rejected by inspectors not because perfect shells could not be turned from them, but because a little more than the contract amount of machining would be required for them. Rather than scrapping these, a small "doctor shop machine equipment" in connection with the tool room will save many dollars and cut the percentage of losses way down. Of course the ideal arrangement is to establish both first-class forging and machining departments and to sell only such forgings as exceed the capacity of the machining and finishing plant.

Before taking up the machining and finishing discussion a few notes should be made on the hydraulic equipment. Here particular care is required in order to obtain a successful operating arrangement especially where such machinery has not been handled before. Long lists of "dos and don'ts" might be compiled, but only a few of the principal sources of trouble can be touched upon.

Do not skimp on any details of foundation design. The usual type of accumulator subjects the foundation to exceptional strains and one would need to witness but once the failure of an accumulator with the accompanying results of some 150 tons, falling possibly fifteen feet or so, to realize the quantity of energy to be dealt with.

Do not skimp in the design of the supply system for the hydraulic pumps. The majority of pump inlets are too small to use as an index for piping sizes, and, with a gravity supply system, inlets at least one or two sizes larger will be found none too small.

Do not skimp in designing piping when balancing expense against the cost of eliminating all sharp turns and elbows. The strains upon hydraulic piping are terrific especially when the operating valves are handled by men thinking only of breaking records on forgings per day.

Again, before discussing the machining and finishing of the forgings, a few facts may also be noted regarding the parts for the shells aside from the forging itself. Large opportunities are open for the manufacture of the brass parts, such as fuse tubes, brass caps, timers and cases, etc. These present no new problems of manufacture, as they are similar to many articles regularly produced in modern brass foundries. The tin powder-cups are very simple. The drop forgings for the diaphragms and the base plates for the different shells offer an attractive inducement to the plant with a drop forging shop, or facilities for installing a drop hammer, furnace, and trimming press. These small pieces require large contracts to make the purchase of an entirely new equipment advisable, but the drop forging business is generally on the increase and advancing with rapid strides along many lines.

Machining and Finishing

The problems to be met and overcome in the operations of machining and finishing are much more numerous than in the case of forging. Instead of two or three operations, twenty-five and more have to be worked out, depending upon the shell considered. The question of help is often a serious item; machinists are scarce these days and very uncertain when obtained. At no time were first-class mechanics in such demand, and shell manufacture calls for a high grade of workmanship. However, many plants by careful tutoring have been able to train young fellows in handling single operations.

The question of machinery forms another important consideration. The technical papers are overloaded with

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advertisements of shell-making apparatus; for practically every operation some special machine has been developed to do the work better or quicker than any other machine. Without going into too much detail a few facts about machinery equipment may be mentioned.

As with the forging operations, profits should be sought in smooth running uninterrupted production and not in bargain machinery. A specific contract should "write off" a certain amount of new machinery, but it will not replace many serious breakdowns and still show profits.. Where possible, standard machines should be installed which may be resold or put to other uses; a machine substantial enough to manufacture shells properly should be good for many places other than the scrap pile after the demand for munitions is over. The best method would seem to be the purchase of lathes with standard beds and headstocks, and only as many accessories, such as compound rests, turrets, etc., as may be required for each operation. Standard parts are obtainable at any time if the machine is to be put to other uses. Strength, durability, and simplicity are the qualities most desired. There are some machines newly developed, such as special nosing and banding presses, varnish drying ovens, painting machines, etc., which involve but a small investment and are well worth the price.

There are in general three systems developed for machining and finishing shells. The first system might be classified as the *automatic*. In this class a relatively large investment in the new and special apparatus recently developed by the energetic machine manufacturers is assumed. Special lathes, automatic milling machines, special grinders, automatic boring machines, special furnaces and presses, etc., all extremely specialized, are available for the concern with large contracts, plenty of capital to invest, and few ordinary artisans to be broken in and taken care of.

The second system might be termed the *standard machine plan with grinder finishing*. In this case standard machines are used, substantial enough to withstand hard wear and service, and equipped with new jigs and tools to perform one or more of the many required operations. The finishing is done on standard grinders with perhaps standard abrasive wheels developed by the manufacturers for this work. Special banding and nosing presses, special heat treatment furnaces, special painting machines, and other new machinery are also used for their special duties.

The third system might be termed the *standard machine plan with machine finishing*. This is similar to the second system, except that available finishing machines are used in the final operations.

The writer will not attempt to enter into the details of machining the various shells. As stated before, there are many ways of rigging the machines as well as several different methods and kinds of machines which may be made to accomplish the same operation; and too, the various operations have been discussed and published at length in many trade papers.

For the majority of manufacturers, the high explosive shell seems the simplest proposition. There are fewer parts to handle and fewer operations; however, one of the chief advantages lies in the absence of any heat treatment such as is required in making shrapnel. The heat treating operation is one of the chief sources of loss and trouble. It is extremely difficult to obtain men with any knowledge and experience to keep the furnaces operating at the desired heat, and to

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understand just when and how to cool the treated shells. Many of the scrapped shells bear the stamp of the heat treating process.

The question of cost of machining and finishing shells is much more involved than in the case of the forging process. More and higher grades of mechanics and of workmanship, more machines, more operations, and more overhead all enter in. The variations in wages, and the question of supply of forgings from another plant or from another department, and the regular overhead charges of the plant make it practically impossible to present an exact figure of manufacturing costs. Where one plant will pay two and a half cents for one operation, another may have to pay five cents for the same work, because of different machine capacities and wage conditions. With carefully analysed conditions and information very close estimates are possible, however.

The required investment for a new plant, exclusive of power and buildings for the machinery, may be quite accurately estimated and will approximate the following figures:

For machining 18-pound shrapnel, an expenditure of $25,000 has been found sufficient for an output of 20 shells per hour; and $15,000 will be sufficient for turning out 10 per hour. For the 4.5-inch (35-pound) shells, $35,000 will be sufficient for an output of 12 shells per hour. For the 5-inch (60-pound) shells, $55,000 for 12 per hour. For the 6-inch (100-pound) shells, $70,000 will be sufficient for turning out 12 per hour.

New contracts are constantly being offered by the representatives of the foreign powers. Many companies already operating are now making two and three kinds of shells. One establishment known to the writer is now manufacturing both forgings and machined shells of the 18-, 35-, and 60-pound types, and has expended over $50,000 on new buildings and some $200,000 on equipment. It is also contemplating additional buildings and equipment for manufacturing shells of larger caliber. All of this work is being carried on while the regular shops are working overtime upon regular business. They have learned the advantages gained through starting early; they have booming stocks, quantities of first-class machinery as additional assets, and also valuable new buildings which will be used in the future development and expansion of their regular business, and all the cost has been "written off" by means of munition manufacture.

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OVERHEAD EXPENSE DISTRIBUTION

By Nicholas Thiel Ficker

VIII. CURRENT VARIATION RATIOS FOR ADJUSTING CURRENT COSTS

In the previous chapters of this series, which began in June, Mr. Ficker has discussed in detail all the items which contribute to manufacturing expense. Last month he summarized the machine-unit system of distribution and found fault with it on the grounds that it is too largely based on estimate and depends upon a "supplementary rate" to make it check with actual manufacturing expense, thereby falling down in times of depression. In this final chapter he points out the way to remedy these defects.—THE EDITORS.

IN the preceding chapter the writer made the statement that the machine unit system depends for its accuracy on what is known as a supplementary rate. It was stated that, this rate is the measure of the undistributed portion of the *current* manufacturing expense to costs of production, expressed in the form of a percentage of the actual expense applied. If the activity of the shop is above normal the rate becomes a minus quantity, while if below normal it becomes a plus quantity. It is obvious, therefore, that the machine unit system is theoretically capable of distributing all of the incurred expense at only one degree of shop activity, and that is at the normal point. The variation between the expense applied and that actually incurred for any period becomes a measure of the extent to which the expense distributed through the medium of the machine unit system will influence costs of production.

To illustrate this point more fully, let us study this relation as expressed graphically by Chart III. We will assume a very simple case of a factory which, under normal operating conditions, has a productive labor pay roll of $500,000 a year, with an equivalent expenditure for shop expense. That is, under normal activity the expense would equal 100 per cent of the productive labor. The writer has used the productive labor in this instance as being indicative of shop activity. Plotting these figures on cross section paper, using the abscissæ for "expense," and the ordinates for "productive labor," we establish the normal points *A* and *F*, from which we can construct the line *C O D* which intersects the lines *A O* and *O F* at the normal point *O*. This line *C O D* we shall call the "standard" or "machine unit" line, as it is indicative of the amount of manufacturing expense distributed to costs of production by the machine unit system at any degree of shop activity.

A study of the expense figures for any factory will show that a certain portion of this expense is fixed; that is, it goes on irrespective of the fluctuating degrees of shop activity. This fixed or "constant" expense is composed of such items as: the salaries of the shop superintendent and his assistants, which go on irrespective of the amount of effort expended by the shop; a certain portion of the power plant expense necessitated for heating, lighting, operating elevators, etc.; rent of buildings or its equivalent, interest on the capital outlay in grounds and buildings; depreciation, insurance, and taxes on the plant and its equipment; fire protection expense; care of the tool equipment; etc. In fact, there are innumerable other items governed by operating factors

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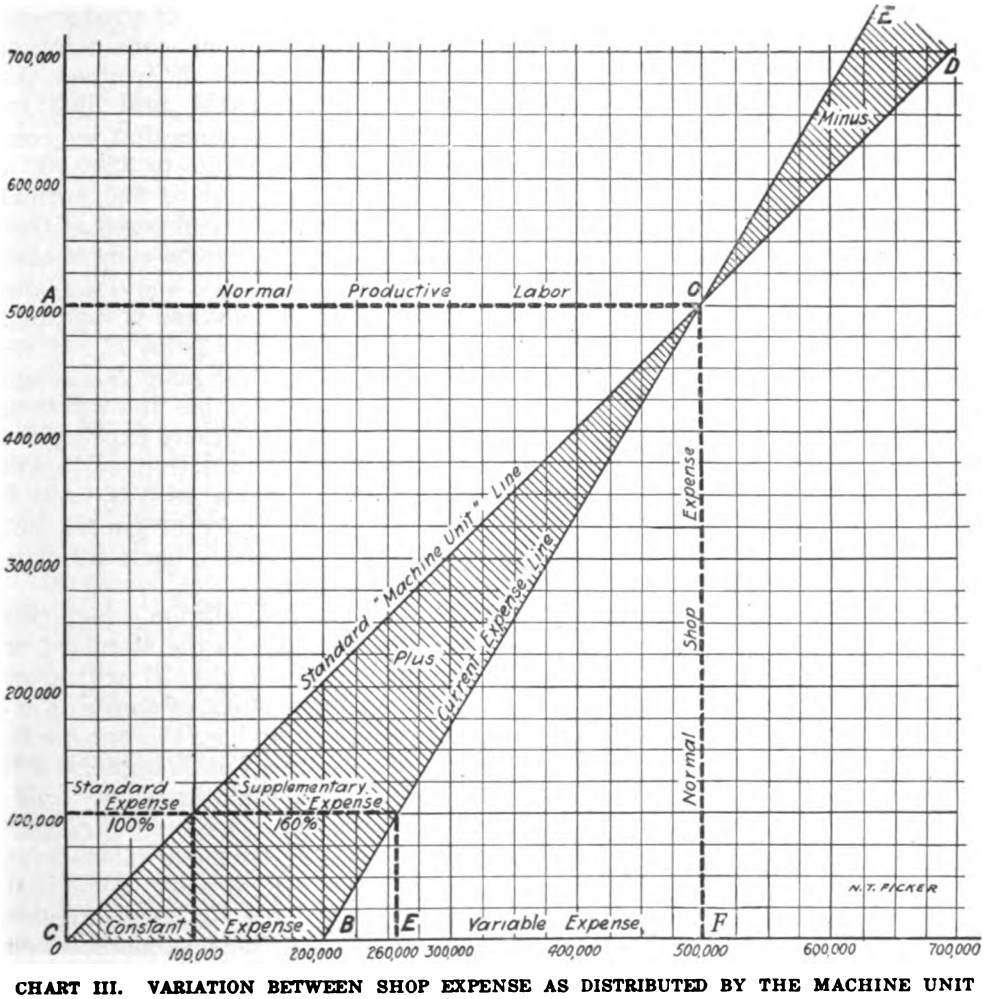

CHART III. VARIATION BETWEEN SHOP EXPENSE AS DISTRIBUTED BY THE MACHINE UNIT SYSTEM AND THE CURRENT EXPENSE FOR ANY DEGREE OF SHOP ACTIVITY

in different kinds of manufacturing, which could be added to those here mentioned. This condition can be fully appreciated by an inspection of the average plant during a slack year, where it will be seen that a large part of its "expense organization" has been kept intact, waiting for a possible increase in production activity. A comparison of the shop expense figures on the books of the company will usually show that while production may have fallen off to practically nothing, expense has not been reduced in anything like this proportion.

The average manufacturing company's organization is composed of three distinct sub-organizations: general, sales, and manufacturing departments respectively. These organizations work independently of each other to a large extent, especially the sales and manufacturing branches. The shop is not concerned with the placing of its product nor with the general financial policies of the company, and hence has very little control, if any, over the volume of its output. Its function consists of meeting the requirements of the sales or-

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ganization as reflected either by filling direct orders or by stocking up to meet future demands, based on the judgment of either the general or the sales branches of the company, or both. It is, therefore, a most difficult matter for the manufacturing branch to anticipate production requirements far enough ahead to reduce its floating or variable expense in proportion.

According to the customary methods of determining costs and distributing overhead, the manufacturing organization is charged with all of the expense due to factors over which it has no control. The functions of the sales and general organizations of a manufacturing company consist of devising means for keeping the shop busy, yet according to present methods the shop is charged with all of the short-comings of these two other branches. Furthermore, in periods of depression costs of manufacture often appear high, when actually the shop management has shown an increase in efficiency that would have been reflected by lower costs if this additional load due to the constant expense were not included. This is readily explained by the fact that the manufacturing expense increases as a percentage of productive labor as the activity of the shop decreases, and is due to the influence of the constant expense which does not show any decrease even at the lowest degree of activity.

A study, made by the writer several years ago, of this very interesting question of "constant expense," showed an average for a number of factories of approximately 40 per cent of the expense incurred under normal operating conditions. This percentage will vary, depending on circumstances, but experience has shown that where all items are considered it will tend to be higher rather than lower.

To illustrate the effect of this constant expense on costs of production, in the factory under consideration for which we have determined the standard or machine unit line on Chart III, let us assume that the constant expense amounts to $200,000 a year, or 40 per cent of the normal shop expense. It is composed of that expense which will go on even if each department has only one man employed in production, and is indicated on the chart by the point *B*. If we draw a line from this point *B* through the normal point *O*, this line will then indicate the approximate expense for any degree of shop activity. It will not necessarily agree with the actual expense for any current period, but will at least be a safe basis for purposes of control.

A study of the relation which this line *B O E* bears to the standard or machine unit line *C O D* will show very clearly the effect of constant expense on costs under different conditions of activity. For example, it will be noted, first, that these lines coincide at only one place, at the normal point *O;* at the $400,000 labor point the expense is already somewhat greater than the expense applied through the machine unit method, and for each lesser degree of shop activity we find a greater variation existing, until at the $100,000 a year productive labor point we find that this expense amounts to 160 per cent of the expense distributed by the machine unit system. Therefore, if a slack period were to reduce the shop activity to one-fifth of its normal activity, we should find a greater portion of the shop expense undistributed than has actually been distributed to costs. This difference is known as the "current variation" and is distributed to costs, in the form of a "supplementary rate" which is added as a percentage to the expense already applied, as shown in the fol-

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Productive Labor (Normal Point at $500,000)	Actual Shop Expense (Constant Expense $200,000)	Estimated Shop Expense Applied to Current Costs by Machine Unit System	Current Variation to be added to or subtracted from Current Costs	Percent Actual Expense of Applied Expense	Percent of Expense Applied, which is to be added to or subtracted from Current Costs
$ 20,000	$212,000	$ 20,000	add $192,000	1060	add 960
40,000	224,000	40,000	" 184,000	560	" 460
60,000	236,000	60,000	" 176,000	393	" 293
80,000	248,000	80,000	" 168,000	310	" 210
100,000	260,000	100,000	" 160,000	260	" 160
120,000	272,000	120,000	" 152,000	227	" 127
140,000	284,000	140,000	" 144,000	203	" 103
160,000	296,000	160,000	" 136,000	185	" 85
180,000	308,000	180,000	" 128,000	171	" 71
200,000	320,000	200,000	" 120,000	160	" 60
220,000	332,000	220,000	" 112,000	151	" 51
240,000	344,000	240,000	" 104,000	143	" 43
260,000	356,000	260,000	" 96,000	137	" 37
280,000	368,000	280,000	" 88,000	131	" 31
300,000	380,000	300,000	" 80,000	127	" 27
320,000	392,000	320,000	" 72,000	123	" 23
340,000	404,000	340,000	" 64,000	119	" 19
360,000	416,000	360,000	" 56,000	116	" 16
380,000	428,000	380,000	" 48,000	113	" 13
400,000	440,000	400,000	" 40,000	110	" 10
420,000	452,000	420,000	" 32,000	108	" 8
440,000	464,000	440,000	" 24,000	105	" 5
460,000	476,000	460,000	" 16,000	103	" 3
480,000	488,000	480,000	" 8,000	102	" 2
500,000	500,000	500,000	.....	100	—
520,000	512,000	520,000	deduct 8,000	98	deduct 2
540,000	524,000	540,000	" 16,000	97	" 3
560,000	536,000	560,000	" 24,000	95	" 5
580,000	548,000	580,000	" 32,000	94	" 6
600,000	560,000	600,000	" 40,000	93	" 7
620,000	572,000	620,000	" 48,000	92	" 8
640,000	584,000	640,000	" 56,000	91	" 9
660,000	596,000	660,000	" 64,000	90	" 10
680,000	608,000	680,000	" 72,000	89	" 11
700,000	620,000	700,000	" 80,000	88	" 12

lowing table for varying degrees of shop activity.

By referring to the table it will be seen that when the activity of the shop is *above* normal this current variation or supplementary rate becomes a minus quantity and the equivalent expense is deducted from current costs instead of being added, as in the instances cited heretofore. The variation in expense for any period is the actual difference between the amount incurred and the amount applied. The line *B O E* can be safely used by the management for estimating purposes when the probable activity can be determined, but the actual adjustment for this current variation is made to conform with the actual current expense for any period. This expense will be somewhere near the expense indicated by the line *B O E* if the figures have been correctly compiled and conditions affecting it have not changed. Differences can be caused, however, by conditions which were not foreseen at the time when the normal expenses were compiled. These may be due to more or less efficient administration of the shop, fluctuations in the prices of supplies and expense materials, such expenditures as extensive repairs which may be of benefit for several

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years, or to the introduction of equipment having a high operating expense but which would be more than offset by a reduction in the productive labor account. Any of these items will affect the relation of expense to labor; hence, the importance of a proper classification of expense items, on which the writer laid particular emphasis in an earlier chapter, will become apparent, as by such a segregation of expenses, abnormal increases can be easily diagnosed and the proper adjustments made for them. These adjustments may also affect the "constant" expense, through such items as variation in the rates for insurance, taxes, etc., and adjustments may have to be made from time to time to correct these expense figures.

In order to note the effect on production costs of a possible period of depression to the $100,000 labor point, let us consider an actual cost summary under both the normal and reduced degrees of activity. A cost, compiled for a certain article which was manufactured when the shop was operating at the $500,000 normal labor and expense point *O*, might show:

Productive Labor	$10.00
Manufacturing Expense 100% of labor (actually distributed on basis of machine hours)	10.00
Material	5.00
Total Shop Cost	$25.00

At the $100,000 labor point, however, this same article would appear to have cost $41, or $16 in excess of the normal manufacturing cost, the cost being made up as follows:—

Productive Labor	$10.00
Manufacturing Expense 100% of labor (actually distributed on basis of machine hours)	10.00
Material	5.00
Standard Cost	$25.00
To which is added, Current Variation (160% of expense)	16.00
Total Shop Cost	$41.00

It is obvious, therefore, that in times of depression when the factory needs business most, its basis of cost figuring for new work is so prohibitive as to make such new business unobtainable. In other words, the present scheme of cost accounting falls down when we need it the most. When the activity is above normal, this same cost would be even less than that shown under normal conditions. Yet at such a time a manufactory could easily shoulder an increase without affecting its normal costs. We must again revert to the factor of constant expense for a cause and solution. We have proved that this expense is the cause of this variation and have likewise shown the lack of responsibility which the management shoulders for this excess burden on the shop. What, then, is the solution?

If a shop has excessive floor space beyond its requirements, the expense incidental thereto would not be a burden on the shop. If a company had three plants and shut two down, it would not charge the remaining one with the upkeep of the two idle ones. Yet, is not this same condition true if we consider each machine as a separate shop, paying for its own rent, depreciation, administration, taxes, tools, etc.; which is precisely what is done in distributing the shop expense by the machine unit system? The facts seem indisputable, and again we ask the question, Why does the shop have to bear this burden? Is the supplementary rate fair to the shop?

During the latter part of the year 1907 and through most of the year 1908, when the financial panic which occurred at that time was manifesting itself with telling effect on every phase of our commercial life, one of the largest manufacturing companies in the country took on contracts for grinding safety razor blades, something entirely different from their regular line of product, on the basis

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of billing this work at shop cost as figured at the normal point and with no other additions for profit, etc. The effect of this policy will be evident when it is seen that by this scheme the activity of the shop was raised to something near the normal point, and, hence, the standard product of the factory was not loaded with the tremendous burden of the constant overhead expense which it would have had to bear if this scheme had not been devised for spreading it over a greater output. In addition to these benefits, it must also be remembered that the manufacturer kept his organization intact, so that when the reaction occurred and business in his line improved, he was in a commanding position over those of his competitors who did not have the foresight to adopt a similar policy.

The writer has cited the foregoing practical example in substantiation of the case against the present practice of charging the current variation, as expressed by the supplementary rate, against the shop. The general or the sales branch of the company in this instance was able to meet the emergency with rare judgment and foresight. Yet if it had failed, would it seem fair to have charged the shop with their shortcomings? It certainly does not seem so, and the more consideration which we give to this phase of production, the more easily is it possible to marshal an indisputable array of facts arguing against the use of the supplementary rate.

There is still another factor of paramount importance pertaining to the supplementary rate. The rapid development of automatic machinery in this country of late years has introduced an element in the form of increased expense with lower labor costs. Where formerly a large portion of manufacturing was done by manual labor, this has now been superseded by machinery, the operation of which entails considerable additional expense. Take, for example, the case of screw machines which have been developed in practically four periods. Originally screws were turned by hand; then pin machines were developed by which the turned parts, which had been cut to size, were threaded automatically; in the third stage, the operations of turning and threading were done simultaneously on a rod which had been cut off to the correct length; finally, the development was carried to the point where drilling, tapping, and slotting were added. Each of these stages of development has increased the expense, but, on the other hand, has reduced manual labor by much greater proportion.

A. Hamilton Church, in his book on "Expense Distribution," says, in justification of the supplementary rate, "Cheaper methods of doing work will be promptly reflected by this rate." They will, but *only* in such instances where no improvements, similar to those of the automatic machines cited above, are made and where the same methods of production exist year in and year out. In a modern manufactory, however, where labor-saving devices are continually being installed, an increase or decrease in expense will not necessarily reflect the efficiency of the shop management and might even indicate conditions directly contrary to those actually existing at the time. Again, in reference to idle time, Mr. Church says, "We are obliged, therefore, from motives of expediency, to look upon idle time as a kind of visitation of 'Providence' which the whole shop ought to bear." The experience of the writer has been that the general management of a manufactory very often finds such visitations of Providence an easy medium for shifting its own responsi-

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bilities. However, if periods of idleness can be traced to Providence, why should the shop be the organization to suffer? Surely, it is not allied with Providence!

It would seem to the writer, from this analysis and from a study of conditions in many plants throughout the country, that there is something fundamentally wrong with our present method of cost compilation. Our costs are useless when we need them the most. We charge the shop with the shortcomings of the sales and general administrative branches of the company, and we look upon an increase in shop expense over a former period of similar activity as being indicative of inefficiency, when the opposite state of affairs may be the true situation. Where shall we look, then, for a remedy? If we do not charge the shop with this variation in expense, what is to become of it? The solution seems to point straight to the management, which alone should assume the "current variation expense," and not the shop. Manufacturing costs would then reflect production efficiency, *not* through the component parts of costs, such as labor, material, and expense, but by the summaries of these three elements for different classes of work. If the shop activity falls below normal, the surplus expense as expressed by the current variation or supplementary rate could be charged to a separate account, where it will remain until it is offset by credits due to activity above normal or until it is charged up to the management.

The expense chargeable against the shop should be that portion of the constant expense which the current activity is of the normal activity, plus the actual current variable expense. That is, if the activity for a certain year was found to be sixty per cent of the normal activity, then the expense chargeable against the shop for that year would be sixty per cent of the constant expense, plus the actual variable expense incurred during that period. At the $100,000 productive labor point on Chart III, the manufacturing expense would be twenty per cent of the $200,000 constant expense ($40,000), plus the variable expense (*B E*) $60,000, making a total of $100,000, which is the same as that indicated by the Machine Unit Line *C O D*. In specific instances this line might be a curve rather than a straight line, but this can be readily determined from an analysis of the expense figures for different periods.

While we have been considering instances where the shop activity has fallen *below* normal, we must not lose sight of the fact that it is just as possible for the output of the factory to rise *above* the normal point as it is to fall *below* it. When the activity of the shop is *above* normal the amount of expense chargeable against costs of production will be *greater* than the actual expense incurred. This additional expense is measured by the variation existing between the machine unit line *C O D* and the current expense line *B O E* at any specific degree shop activity. It will, therefore, be seen that inasmuch as the expense applied through the machine unit system as indicated by the line *C O D* will be *greater* than the actual shop expense incurred as indicated by the line *B O E*, then when the shop is operating *above* the normal point this excess expense naturally becomes a credit to the general management. Credits of this nature will tend to offset charges made against the management when the factory is operating *below* normal and will, if taken over a period of years, reflect the efficiency of the administration.

A careful analysis and study of the

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method herein advocated by the writer, will show several very decided advantages over the old method of applying a supplementary rate. By this new method, the shop in times of prosperity will absorb a greater amount of expense than is actually incurred, which will tend to offset and equalize benefits which it has derived during periods of depression. In like manner the general management will receive credit for increasing the production activity *above* normal and in this way have a chance also to equalize charges which were made against it during periods when the production fell *below* normal. By this method costs will be low when business is most needed and will be higher when business is more easily obtainable. Furthermore, shop costs will be comparative and will reflect the efficiency of the shop administration for different periods.

The writer has endeavored to point out in these eight chapters on Manufacturing Expense Distribution the ramifications of this most important element pertaining to production, and has hoped to show the effect of both correct and incorrect methods of distributing this expense on the ultimate achievements of a manufacturing business. The manufacturer, who today looks upon his so-called "overhead" as a loss, is far behind the procession, and he must either get abreast of it or fall by the wayside. Expense today, as exemplified and incurred by planning and routing departments, statistical corps, time studies, and all of the other phases of scientific management, is a necessary adjunct to production, and should really cease to be classified as expense in the strict sense of the word. Manufacturers are often too prone to consider the terms "waste" and "expense" as synonymous. The extent to which cost reduction can be carried depends to a large degree upon the capacity of the management to incur expense with this end in veiw. Too much emphasis cannot be laid, therefore, on the proper interpretation of what we have chosen to call "expense." Some manufacturers who still consider the term in its old sense remind the writer of the story told of the farmer who criticised the city clocks for the reason that, of the five he saw in the course of a mile walk, no two agreed as to the time.

Conditions change, progress is being made, and new methods are being developed from day to day on the basis of past experience. Hence, it behooves those who would forge ahead to keep posted on these various changes.

The End

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THE NEW FORD LINE-UP

By Fay L. Faurote

As soon as the news of the resignation of James Couzens was announced, Mr. Faurote set to work immediately to discover what the effect would be upon the personnel of the Ford company. The result of his findings prove that the organization established by Mr. Ford and Mr. Couzens is so complete that as an institution it will continue to move efficiently and smoothly.—THE EDITORS.

THE industrial spotlight is again focused on the Ford Motor Company of Detroit—James Couzens, Vice-President and Treasurer, resigned on October 12th. A special Directors Meeting was held the following day, when his resignation was accepted to take effect November 1st. Frank L. Klingensmith, former Secretary of the Company, was elected to succeed him as Treasurer, and Edsel Bryant Ford, twenty-two year old son of Henry Ford, was made Secretary. No further changes in the personnel have been announced, as Henry Ford and his family left for California the next day, and immediately upon his return became interested in the endeavor to promote peace between the warring countries of Europe.

There has been much speculation as to what other changes will be made in the organization upon Mr. Ford's return, but Ford officials have declined to discuss the matter.

It is rumored that the immediate cause of the break between Mr. Ford and Mr. Couzens, which came after close association of thirteen years, was due to the difference in opinion on military preparedness and to other matters pertaining to the peace propaganda with which Mr. Ford has lately been identified.

James Couzens was born in Chatham, Ontario, August 26, 1872, where he remained until he was 15 years old. He received his education in the public schools of that city. During his spare time he worked on a railroad, and later became operator on the Erie and Huron. When he reached the age of seventeen, becoming dissatisfied with "life in a small town," he came to Detroit, where he got a position as car checker on the Michigan Central. It was here that he received much of the valuable experience and discipline which have stood him in such good stead in his later active executive career. He spent five years at this job, when he was given a position in the freight office at the salary of $60 per month. During this period of his life he met A. Y. Malcomson, Vice-President and Treasurer of the United Fuel and Supply Company of Detroit. Mr. Malcomson was conducting a large coal business and handled a great many cars. He felt the need of a man to take charge of this end of his business and, therefore, offered Couzens a job as bookkeeper at $75 per month, which was accepted.

One day a man by the name of Ford, an engineer in the Edison Company's plant, came into the office to interest Mr. Malcomson in an automobile which he said he believed could be manufactured and sold in large quantities. Malcomson finally consented to put money into the proj-

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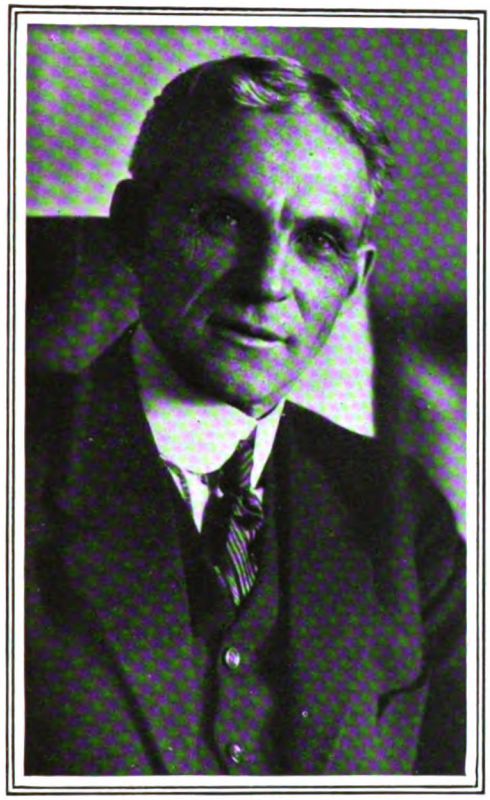

HENRY FORD
President, The Ford Motor Co.

JAMES COUZENS
Former Vice President and Treasurer

ect with the understanding that he would be allowed to place a personal representative in the office. The deal was put through, and James Couzens thus became identified with the Ford Motor Company as Mr. Malcomson's special representative. Ford was made Vice-President and General Manager at a salary of $300 a month, and Couzens, Secretary, at $200 a month.

A six per cent dividend was paid in 1903. Later, Malcomson, feeling that the automobile business was not developing as rapidly as he thought it should, sold out his shares to Mr. Ford and Mr. Couzens. Once again, Malcomson bought in, and again his interests were absorbed by Mr. Ford.

Meanwhile the affairs of the new company were progressing more smoothly, and finally, when Ford became President, Mr. Couzens was elected Vice-President and Treasurer. Since that time, these men have been closely associated and have built up one of the most marvelous industrial institutions that this mechanical age has produced. It is said by many, who claim to know much of the inside workings of the Company, that Mr. Couzens has been largely responsible for the financing of the Company, and also for the building up of the successful sales organization which, annually, succeeds in disposing of 300,000 cars.

Of course, Mr. Ford and Mr. Couzens have had differences; matters of policy were constantly coming up.

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Sometimes they agreed—sometimes they did not; but after friendly argument, one would either succeed in convincing the other of the merit of the plan, or by mutual consent it was abandoned.

Of late, however, it is understood, that many of Mr. Ford's policies have not found favor in Mr. Couzen's eyes. As he says, in an interview given to one of the Detroit papers, "Mr. Ford and myself found that there was an honest difference of opinion between us as to some of his public utterances." Both men were very quick to deny intimations that there was a serious break in their friendship, and while of course Couzens will retire as an active official of the Company, he will still retain his financial interest and continue to be a member of the Board of Directors. He controls about 12 per cent of the shares, and also holds some of the Canadian Ford stock. Dodge Brothers, who severed their active connection with the Ford Company sometime ago, have 10 per cent; the Gray Estate, about 10 per cent; Horace Rackham and John W. Anderson, about 10 per cent; and Henry Ford, 58 per cent.

Due to the fact that it was decided to change the end of the fiscal year from September 30th to July 31st, the Ford Motor Company's balance sheet shown herewith covers the business for only ten months. As will be seen, the enormous surplus of $59,135,770.66 has been set aside. This is an increase of $10,308,738.59 over the 1914 surplus; $31,011,507.66 more than the surplus of 1913; and an increase of $44,309,675.09 over 1912. Cash on hand on business of ten months shows a total of $43,788,151.23; as compared with a statement given out September, 1914, for the twelve months total of $27,441,468.79, this shows an increase of $16,346,682.44 in ten months. The cash balance for 1913 was $13,225,710.82; in 1912, only $6,400,100.66.

FORD MOTOR CO.'S BALANCE SHEET

	ASSETS 1912	ASSETS 1913	ASSETS 1914	ASSETS 1915
Cash on hand and in banks	$6,400,100.66	$13,225,710.82	$27,441,468.79	$43,788,151.23
Michigan municipal bonds at cost	1,075,051.48	1,283,943.59	1,330,546.84	1,311,924.10
Accounts receivable	230,912.17	448,233.98	3,233,582.73	2,300,456.42
Merchandise inventory at cost	6,629,533.83	9,046,171.68	9,284,449.26	14,335,767.87
Outside investments	7,772.04	7,433.32	9,200.00	9,200.00
Prepaid expenses	44,591.07	215,259.29	437,089.77	385,377.56
Real estate	820,636.97	1,540,483.42	2,227,567.88	3,148,263.01
Buildings and building fixtures	2,596,11,.61	4,615,156.82	10,714,928.45	12,931,884.45
Factory equipment	371,110.90	676,589.49	1,661,155.23	2,606,376.06
Furniture and fixtures	58,059.39	77,357.60	105,263.95	328,497.30
Power plant and machinery	1,843,967.02	2,832,907.33	3,821,465.38	5,693,648.50
Tools	566,510.17	824,901.04	1,199,779.11	1,491,824.85
Patterns	66,884.06	92,710.13	105,992.30	142,998.22
Patents	51,793.96	57,224.27	59,767.47	61,472.84
Machinery, tools and equip. at branches	52,746.30	.....	.....	.....
Total	$20,815,785.63	$35,033,919.86	$61,632,257.16	$88,535,840.41
	LIABILITIES			
Accounts payable, not due	$2,261,026.63	$3,049,586.86	$3,335,139.01	$4,947,805.81
Accrued pay rolls	149,166.45	191,940.70	537,489.70	428,907.14
Accrued salaries	12,327.45	24,169.30	44,229.95	341,814.16
Accrued expenses	178,766.10	266,119.43	218,140.50	463,111.47
Contract rebates	58,350.00	25,960.00	621,381.12	1,281,661.01
Contract deposits	.....	.....	1,452,622.82	1,968,844.89
Reserve for refunds to take care of reduction in price	75,000.00	.....	.....	.....
Reserve for employes' bonus	242,033.80	134,999.96	.....	.....
Reserve for bad debts	3,655.04	3,510.55	.....	.....
Reserve for depreciation of fixed assets	742,626,89	1,061,805.25	1,935,440.07	2,885,188.94
Reserve for depreciation of patents	51,793.96	7,224,27	59,767.47	61,472.84
Fire insurance reserve	11,900.40	34,059.63	43,934.45	51,263.49
Reserve for profit-sharing	.....	.....	2,557,080.00	15,000,000.00
Unearned profits—branches	284,043.34	60,370.23	.....	.....
Capital stock	2,000,000.00	2,000,000.00	2,000,000.00	2,000,000.00
Surplus	14,745,095.57	28,124,173.68	48,827,032.07	59,135,775.66
Total	$20,815,785.63	$35,033,919.86	$61,632,257.16	$88,535,840.41

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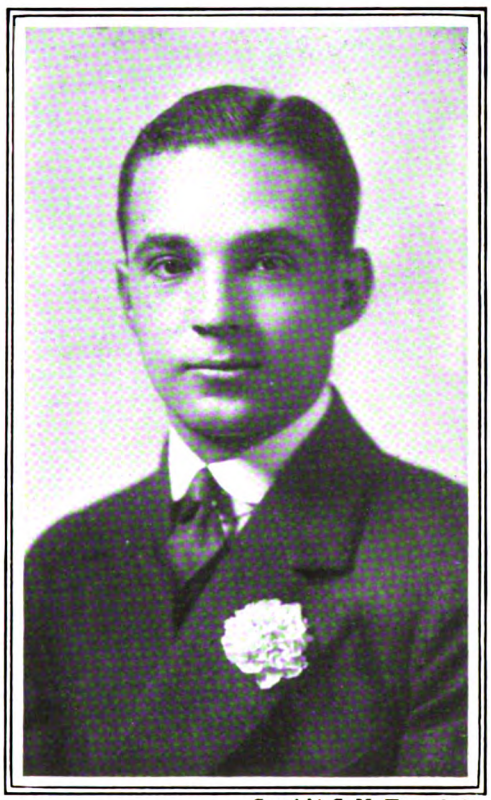
FRANK L. KLINGENSMITH

Formerly Secretary, now the Vice President and Treasurer



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EDSEL BRYANT FORD

22-year-old son of Henry Ford, the newly appointed Secretary

"What is to be the New Line-up now that Mr. Couzens is out?" I asked Mr. F. L. Klingensmith, the new Vice-President and Treasurer.

"Outside of the fact that I have been made Treasurer and Mr. Edsel Ford has been elected Secretary, there are to be no changes; at least none that I know of," said Mr. Klingensmith, in his characteristically frank manner. "As you know, the Ford Company is a one man institution. Henry Ford is the head of it and the rest of us are his lieutenants. While he may make some changes when he gets back from California, yet I do not know of anything that he contemplates doing now. I would suggest that you wait until he gets back and talk to him personally."

"Will there be any changes made in the personnel of the shop?" I asked another Ford man.

"Not that I know of," said he, "except that they may take some of the boys down to the Tractor plant which is being erected in Dearborn.

"Of course, we are always making changes out here. The plant never looks the same week in and week out; but that is progress you know, that's the reason the Ford Motor Company is what it is. We never stand still—the moment we find some better way of doing a thing or some better man to do it, we start about doing it that way. Another thing about Mr. Ford is—he doesn't believe in titles. He believes in developing men. He feels, in as large an organization as the

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NORVAL A. HAWKINS
Sales Manager, the Ford Motor Co.

C. HAROLD WILLS
Chief Engineer, the Ford Motor Co.

Ford Motor Company, there is always to be found the proper place for a man. It may take time to put him there, but ultimately he will find his niche and there is where he will do his best. So he changes us around—he is a keen judge of human nature. It doesn't take him long to find out what a man can do best; and the best part of it is that when he moves a man from one position to another, the salary goes with it. Not long ago he took an Assistant Branch Manager, who was getting $2500 a year, and put him at the head of a branch where he is now earning $12,000. He gives all of us a chance. Just as an illustration, let me relate a little incident in connection with the building of the model of the Ford Motor Company now out in our exhibit at the San Francisco Fair. When we decided to build this, we got bids from the outside which we found were very high. While we were considering the advisability of having an outside concern make it, one of the men in the shop came to us and said, 'I believe I can make that, if you will let me.' We turned him loose, and the result is a wonderful model, complete in every detail. It is made to exact scale and is a faithful miniature reproduction of the entire plant, including the new power plant. It was made in its entirety in the Ford shops by Ford workmen. Needless to say it cost us several thousand dollars less and is much better than we could have secured outside. Incidentally it may interest you to know, that while working on this model, we discovered

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a special way of molding metal which has resulted in a saving of thousands of dollars in our regular manufacturing work.

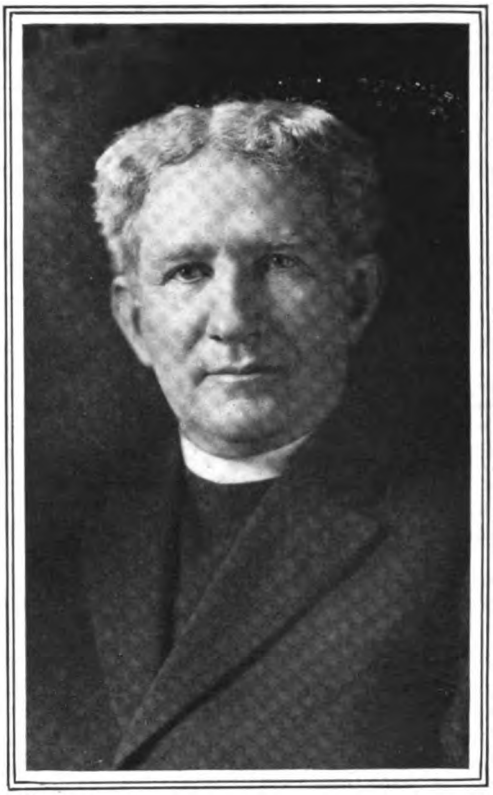
"I only tell you this to show you Henry Ford's way of doing things. He is going after the tractor business in the same way. He is not following any beaten paths. The probabilities are that the tractor plant will be as unique and original as the automobile plant. For instance—it is understood that there will be no stockholders, no directors, and no incorporation. Every man employed, during the period of his empolyment, will share in the profits of the industry. The first two new buildings have been completed and machinery is being installed. The factory will be completely equipped for the construction of the tractor from raw material to the finished product."

Simultaneously with Mr. Ford's return from the coast on November 15th, announcement was made in Detroit papers that the Rev. Samuel S. Marquis, Dean of St. Paul's Cathedral, had accepted an invitation to join the Sociological Department of the Ford Motor Company.

When Mr. Ford heard of Dean Marquis' action, he was very much pleased, and said: "I am mighty glad to hear it. There is a fine work to be done and I believe he is the man to do it."

It is understood that, since taking over the Detroit General Hospital, Mr. Ford has done a great deal of good in the reclamation of unfortunate men, who thought they were hopeless victims of alcohol, drugs, or criminal habits.

The acceptance by Dean Marquis of this invitation to join hands with Henry Ford in this practical work, calls public attention for the first time to a phase of Ford activities which have been silently going forward in the Ford organization for several years.



DEAN SAMUEL S. MARQUIS
Head of the Sociological Work

Henry Ford's doctrine of "Help the other fellow" is no meaningless motto, but a sincere, unselfish, operating principle of his business. A principle that has not only made him money—which, of course, it is right that it should—but is helping to make men mentally and morally better.

The Ford Motor Company is an institution—an enormous institution—so large that no one man can control its destiny—not even Mr. Ford himself. While it clearly reflects the great genius of its founder, it moves efficiently, even when he is away.

So what is the New Line-up? There *is* no New Line-up. A few changes perhaps—there are always changes.

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HANDLING MATERIALS IN MANUFACTURING PLANTS

By Robert L. Streeter

III. BELT CONVEYORS—FLIGHT CONVEYORS—APRON CONVEYORS—BUCKET CONVEYORS

In the two previous chapters Mr. Streeter has described the various types of heavy mechanical devices for handling material, taking up, first, the equipment for unloading bulk material in the factory yards, and, last month, the types of cranes used witnin the plant. This month he studies the types of true conveyors and presents formulae for determining their load capacity. Later subjects to be treated are: Hoists and Elevators, Trucks, and Carrier Systems.—THE EDITORS.

OF all the terms used in connection with handling materials the word conveyor is probably more abused than any other. Strictly speaking all cranes, trucks, and many hoists, are also conveyors but are not so termed, that word being reserved for certain types of machines which form endless belts or chains. The belt conveyor is probably the best known and the most generally used type of "conveyor." Next in order might come the bucket type. Others are the flight, apron, pan, cable, and screw conveyors. These are all used primarily for handling bulk material, although, with the exception of the bucket and pan types, any one may be used for handling packages. We might add to the list the pneumatic conveyor; a system in which light bulk material is blown or drawn through pipes. Obviously this last form of conveyor is not adapted to handling packages, but can be used to good advantage for handling wool, cotton, rags, refuse from wood-working machines, etc.

The conveyor, irrespective of type, differs from the crane in that it conveys only and does not hoist, or, in other words, it cannot pick up its own load. In any type the load must be delivered to the conveyor at a fairly uniform rate in order to have the work done efficiently. The belt conveyor may be loaded from a spout, the stream of material being unbroken. The bucket conveyor must be fed intermittently or in such a manner that each bucket receives a full load. This may not be the case in types in which the edges of the buckets overlap. The pan conveyor is similar to, and is loaded in the same manner, as the bucket type while the apron conveyor is used only for packages, and the manner of loading depends entirely on the size and weight of packages handled. The flight and cable conveyors are similar in appearance and action. The former consists of a number of flights or scrapers attached to one or two chains or cables, while the cable conveyor consists of a single endless cable to which are secured blocks or scrapers which move the material in a trough. The screw conveyor is formed by winding a steel plate on a shaft in the form of a helix. The shaft carrying the helix is enclosed in a tube or it

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may be placed in a trough. It is evident that if the shaft revolves the helix will carry along any material that is small enough to drop between two turns of the helix.

Belt Conveyors

The simplest type of endless conveyor is the belt running over pulleys and supported throughout its length by idlers on both the carrying side of the belt and the return. Obviously, the idlers on the return side may be spaced farther apart than those on the carrying side. When a belt is used for carrying packages it is supported on flat idlers, and the material is prevented from falling off the belt by means of sides which, with the belt, form a trough rectangular in section. Materials in bulk such as coal, limestone, ore, sand, grain, etc., are almost invariably carried on troughed belts, that is, belts with the edges turned up and inclined to the plane of the belt so that the belt forms a trough which retains the material.

The original troughing idler consisted of a spool-shaped roll or pulley, or a series of individual pulleys mounted so as to form a spool. This type of pulley served the purpose of holding the belt in its proper shape, but it had one very undesirable feature. The peripheral speed of the pulleys varied as the diameter varied and, as the speed of the belt was constant throughout its width, there was considerable friction between the belt and certain portions of the idle pulleys. This friction caused a scouring action which wore the belt out rapidly; it was also responsible for the low efficiency of that type of installation.

Troughing idlers are now almost invariably constructed of several individual pulleys so mounted that all but the center pulley are inclined at an angle with the horizontal, thereby causing the belt to form a trough conforming closely to the arc of a circle. These pulleys are usually, but not always, mounted in the same plane perpendicular to the line of motion of the belt. Lubrication is accomplished in several ways. The shafts carrying the idlers are sometimes made hollow and this space is filled with grease or oil which gets to the bearings through small holes. Another method is to use shafts with small holes bored through them in a longitudinal direction, and with other holes to carry the grease from the longitudinal hole to the bearing. Grease is then supplied by a screw grease-cup. Particular care must be taken to prevent the lubricant from coming in contact with the belt, as grease or oil has a harmful effect on rubber.

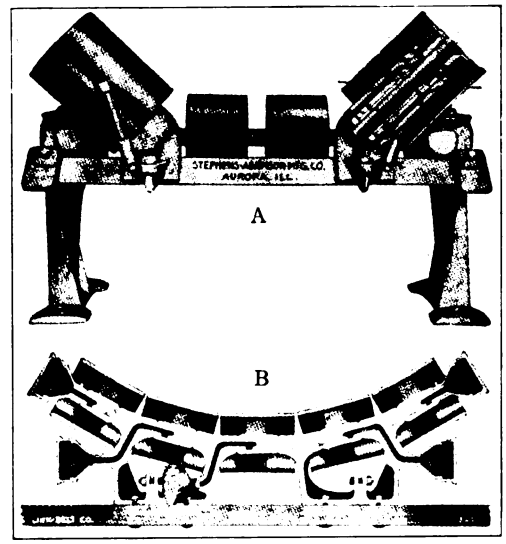

FIG. 1. TWO SYSTEMS OF LUBRICATION, BY OIL AND BY GREASE

Two methods of lubrication are shown in Figure 1, the idlers at *a* being lubricated by oil, and those at *b* by grease applied by means of compression cups. The inclined idlers run in a well of oil as indicated, the bearing sleeve in which the idler stem turns being of babbitt. The horizontal idlers are fastened to the cross-

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FIG. 2. ROBINS CONVEYOR AT MARYLAND STEEL COMPANY
Showing grease cups and inclination of idlers

FIG. 3. STEPHEN-ADAMSON CONVEYOR CARRYING LIMESTONE
Idlers in this installation are lubricated by grease cups

shaft which runs in bearings at either end, these bearings being lubricated by brass rings running in oil wells. The idlers shown at *b* are lubricated by individual grease cups which force the grease into the bearing through holes in the brackets and idler pins. The manufacturer of this type also make a system whereby all five idlers are lubricated from two cups, one at either end.

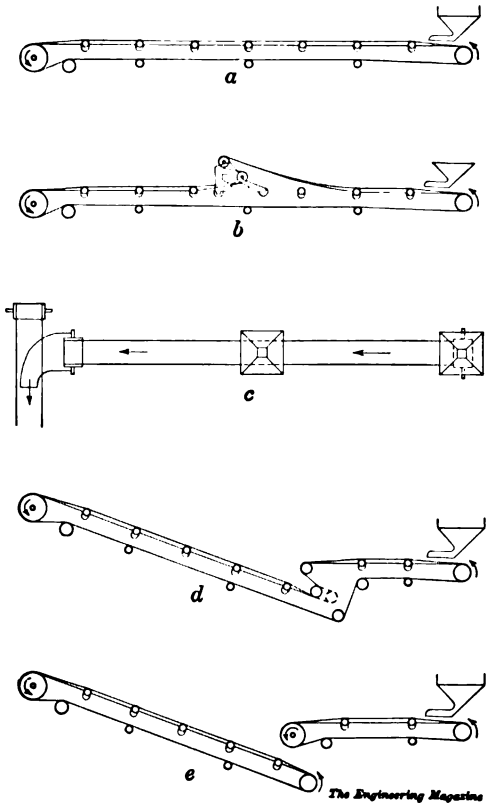

FIG. 4. SEVERAL ARRANGEMENTS OF BELT CONVEYORS, LOADING HOPPERS, AND TRIPPERS

The angle with the horizontal made by the inclined idlers varies from 10 to as much as 45 degrees. Conveyors which have troughs formed by the greater angles have slightly greater capacities than those using the smaller angles, but the increase in capacity gained by using the large troughing angles is probably more than offset by the increase in friction and the decrease in the life of the belt. Some of the most successful companies installing belt conveyors never use greater angles than 25 degrees, and the average falls below this figure. With this angle it is possible to attain 85 or 90 per cent of the theoretical carrying capacity of the belt, while the full capacity is never reached even with the maximum troughing angles. A deeper angle is sometimes used at the loading point of the belt, as such an arrangement seems to facilitate the proper loading of the material on the belt.

The spacing of idler rollers and the manner in which a belt with a load

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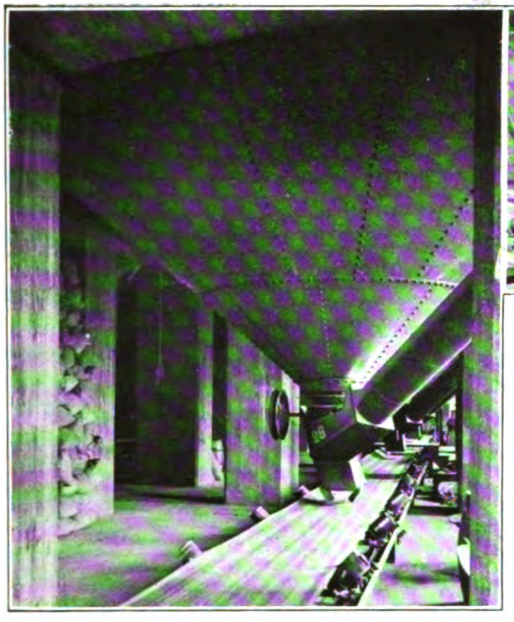

FIG. 5. WEBSTER CONVEYOR IN GRAIN ELEVATOR, SHOWING LOADING CHUTE

conforms to the curve formed by the idlers are shown in Figures 2 and 3. The former is a 30-inch belt handling limestone from a crusher, maximum size of stone being 8 inches. The belt illustrated in Figure 3 is conveying screened coke. It is 36 inches wide, 198 feet between centers, and is driven by a 15-horsepower motor. The grease cups used for lubrication are plainly visible.

It is safe to say that there is no standard arrangement for a belt conveyor; that is, a belt conveyor is not made up with a standard distance between centers, standard location for loading hoppers, standard location of trippers, etc. Each installation calls for something out of the ordinary, something that the last installation did not and the next installation will not require. It would be folly to try to illustrate and describe the various combinations that can be made up of belts, loaders, and trippers, but a few of them are shown in Figure 4. The

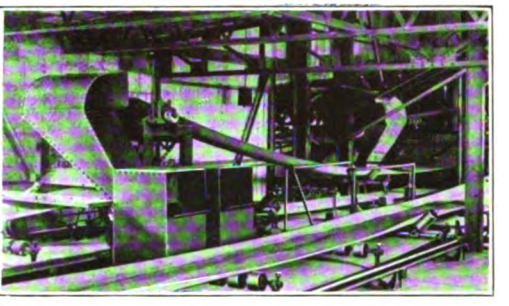

FIG. 6. WELLER CONVEYOR IN TOP OF LARGE GRAIN ELEVATOR

Trippers discharge into various spouts which in turn deliver to cars or boats

simplest one is that shown at *a*, the one that can be installed at the lowest cost. It is applicable for any work where the load may be put on at a given point and discharged over the drum at the other end of the conveyor. In cases where the load must be put on at several points alternately, the only added complication is to install additional loading hoppers.

The application of the multiple-loading hopper system is clearly shown in Figure 5, which illustrates a Webster belt in the Wheeler Grain Elevator, Buffalo, N. Y. This belt runs under one row of bins, delivering the grain for shipment to wagon, railway car, or canal boat.

There are many kinds of work, however, such as storing material in long bins, that require unloading to take place not at the end of the belt but at various places along the bin. This may be accomplished in several ways, one of which is illustrated at *b*, Figure 4. Here a movable tripper is used. As the belt goes around the high pulley of the tripper, the material is thrown forward into a chute which allows it to flow to one side away from the belt. These trippers are placed on wheels which run on rails at either side of the belt, as shown in Figure 6. In this particular instance the belt, installed by the Weller Manufacturing Company of

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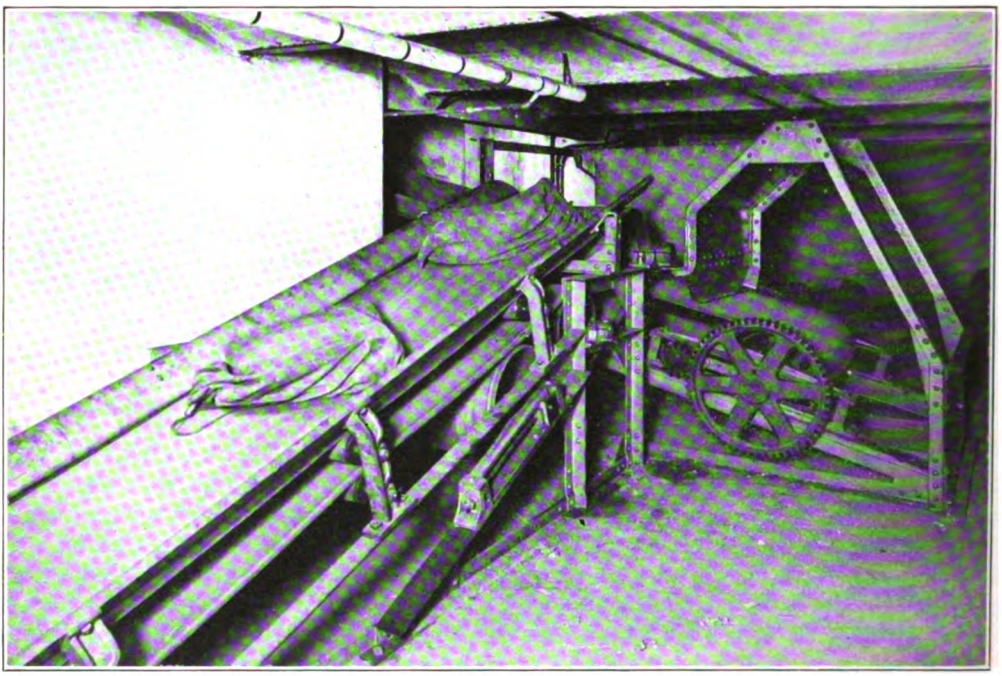

FIG. 7. JEFFREY CONVEYOR DRIVEN BY AN ELECTRIC MOTOR THROUGH GEARS

Chicago, is conveying grain along the top of an elevator and discharging it into one of the various spouts which in turn deliver it to cars or boats. The right hand conveyor is delivering grain through a similar tripper to a spout further along. The construction of the tripper track is exceptionally well illustrated in the right hand belt.

In some cases where material is to be discharged at several fixed points, a number of fixed trippers may be used.

It is often necessary to change the direction of a belt conveying system. Wherever this is necessary two or more belts should be used. At *c* in Figure 4 is shown, in diagram, the application of two belts where it is necessary to deliver material around a corner. It will be noticed that the spout which receives the material from one belt and delivers it to the other is turned through 90 degrees, so that the material may be delivered to the second belt with some velocity in the direction of that belt.

The various forms of belt conveyors mentioned above are applicable to inclined as well as horizontal belts. In some cases it is necessary to use combinations of horizontal and inclined belts. The simplest way to effect this combination is to use one continuous belt and run it over a series of pulleys arranged as a tripper at the point where the belt changes from the horizontal to the incline. The material is then dropped from the horizontal portion of the belt to the inclined portion in the manner illustrated in Figure 4, *d*. The same result may be secured by using two belts as shown at *e*, Figure 4. The horizontal belt in this case is entirely separate from and discharges material directly upon the inclined belt.

The capacity of a given size of belt delivering bulk material is fairly well

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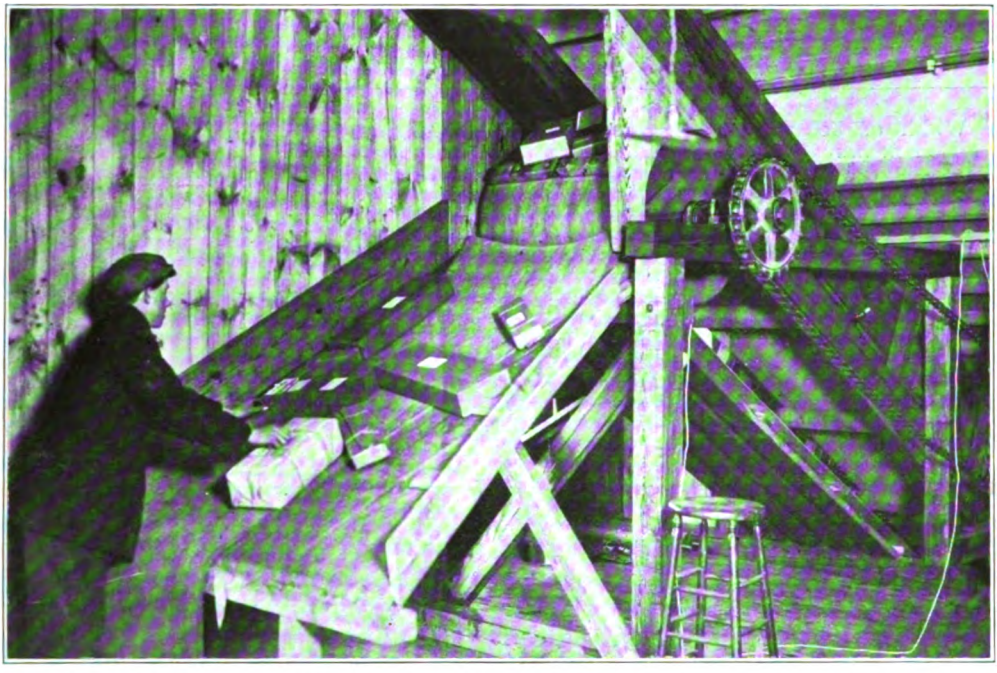

FIG. 8. JEFFREY CONVEYOR DRIVEN BY MEANS OF A LINK BELT

fixed, and varies only with the speed of the belt and weight of the material. A formula for finding the capacity of a given belt is given by Mr. Reginald Trautschold in the *Canadian Engineer* for September 18, 1913. It is

$$W = \frac{1.43\ w^2\ VW^1}{100{,}000}$$

where W = weight of load conveyed in tons per hour,
w = width of belt in inches,
V = velocity of conveyor in feet per minute,
W^1 = weight of material handled in pounds per cubic foot.

The question of the proper speed for a belt used as a conveyor has caused much discussion in the past and is still a matter of controversy. Ordinarily, heavy materials can be carried at a much higher speed than lighter ones, but of course there are exceptions to this rule. The variation in the advisable speed is not great, being from 250 to 400 feet per minute, with 300 as a good average speed for all conditions. It might also be said that wide belts may be run at relatively higher speed than narrow ones.

Table I gives capacities of belt conveyors handling material weighing 50 pounds per cubic foot, the capacities being in tons per hour. The capacity of a given belt carrying material whose weight is not 50 pounds per cubic foot may be found by direct proportion. For material weighing 75 pounds per cubic foot the capacities would be 50 per cent greater than those given in Table I, and for material weighing 100 pounds per cubic foot the capacities would be double those given. The values given in Table I are from data furnished by the Link-Belt Company of Chicago and do not conform exactly to the values which may be found by using the formula given, but they do correspond to a similar formula in which the constant is 1.65 instead of 1.43.

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TABLE I

CAPACITIES OF BELT CONVEYORS IN TONS. CARRYING MATERIAL WEIGHING 50 POUNDS PER CUBIC FOOT

Width of belt in inches	Velocity in feet per minute										
	100	150	200	250	300	350	400	450	500	550	600
12	10	16	21	26	31	37	42	....	....	....	....
14	13	20	27	34	41	48	55	....	....	....	....
16	18	28	37	46	56	65	75	....	....	....	....
18	26	40	52	65	81	91	105	118	....	....	....
20	32	48	65	81	97	113	130	146	....	....	....
22	38	58	77	96	116	135	155	174	193	....	....
24	47	71	95	118	142	166	190	213	237	....	....
30	75	112	150	187	225	262	300	337	375	412	....
36	105	157	210	262	315	367	420	472	525	577	....
42	130	195	260	325	390	455	520	585	650	715	....
48	195	292	390	487	585	682	780	877	975	1072	1170
54	275	412	550	687	825	962	1100	1237	1375	1512	1650

Like all other conveyors, belts should carry their full load. There is no economy in running at a given speed with only half load; it is better to reduce the speed and run the belt full. The width must frequently be determined by the size of the material handled rather than by the actual carrying capacity. In such cases the speed may be advantageously reduced. The following are the maximum sizes of lumps that it is desirable to handle with given widths of belts:

12-inch belt.....	2-inch
18-inch belt.....	4-inch
24-inch belt.....	8-inch
30-inch belt.....	14-inch
36-inch belt.....	18-inch

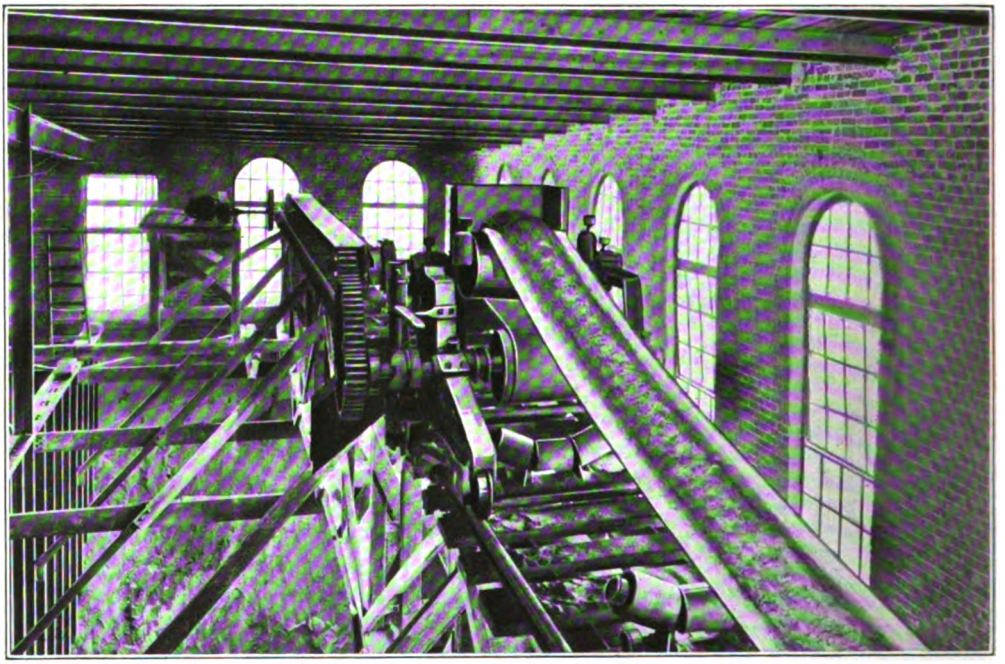

FIG. 9. LINK-BELT COMPANY'S BELT CONVEYOR WITH TRIPPER UTILIZED FOR DRIVING

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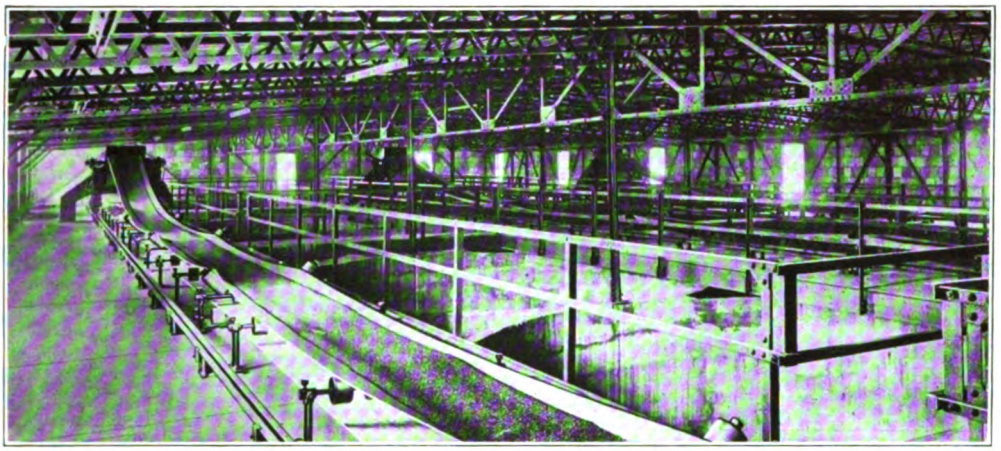

FIG. 10. WELLER BELT CONVEYORS DISTRIBUTING GRAIN IN HEAD HOUSE OVER STORAGE TANKS

The capacities given in Table I are for horizontal belts. In general, it might be said that these figures as given in the table should be reduced from 5 to 10 per cent for inclined belts, the amount of reduction depending on the angle of inclination.

As in the case of any mechanical conveyor, power is required for three distinct operations when operating a

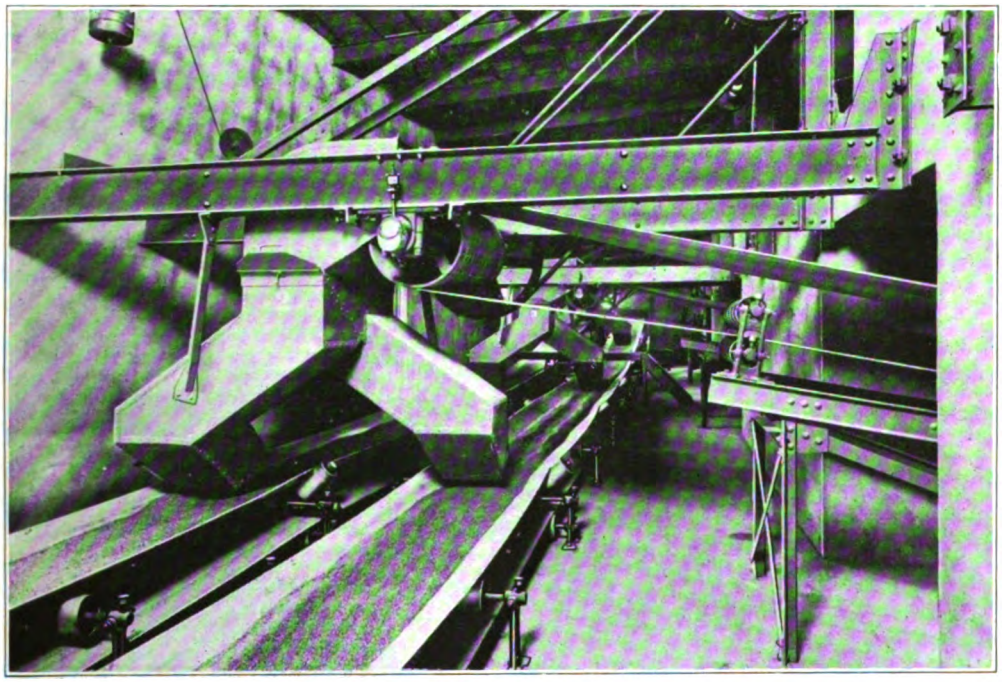

FIG. 11. CROSS BELTS UNDER THE STORAGE TANKS WHICH ARE FILLED BY THE BELTS SHOWN IN FIG. 10

These cross belts carry the grain to a main conveyor which in turn takes it to the loading out spouts

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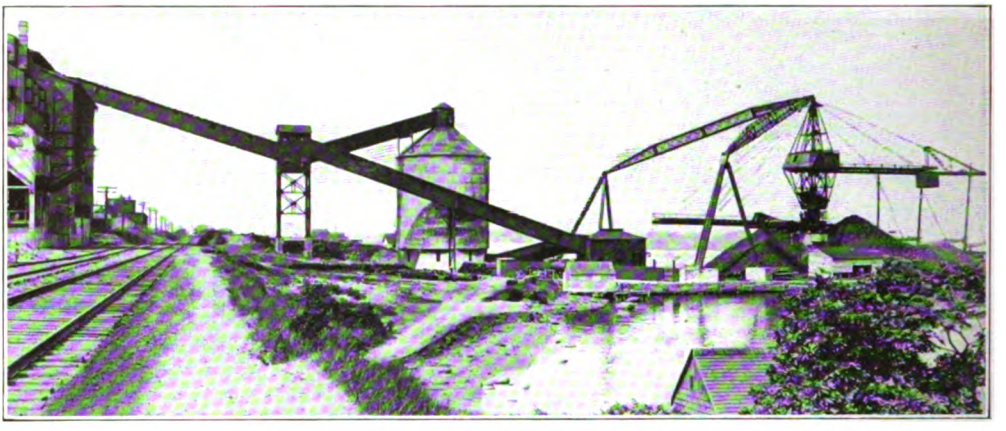

FIG. 12. GENERAL VIEW OF COAL STORAGE PLANT BUILT BY THE STONE AND WEBSTER ENGINEERING CORPORATION FOR THE FALL RIVER GAS COMPANY
Belt conveyors were furnished by the Robins Conveying Belt Company

belt conveyor system. The first operation is in running the conveyor idle, neglecting all loads except the belt itself. This might be termed the friction power. If the power unit is a horsepower the formula for expressing the friction power would be

$$\text{Friction Horsepower} = \frac{a\, w_b\, VL}{33{,}000} \quad (1)$$

where

a = a constant,
w_b = the weight of the belt per foot in pounds,
V = velocity of belt in feet per minute,
L = length of belt between centers of pulleys.

The horsepower required to convey

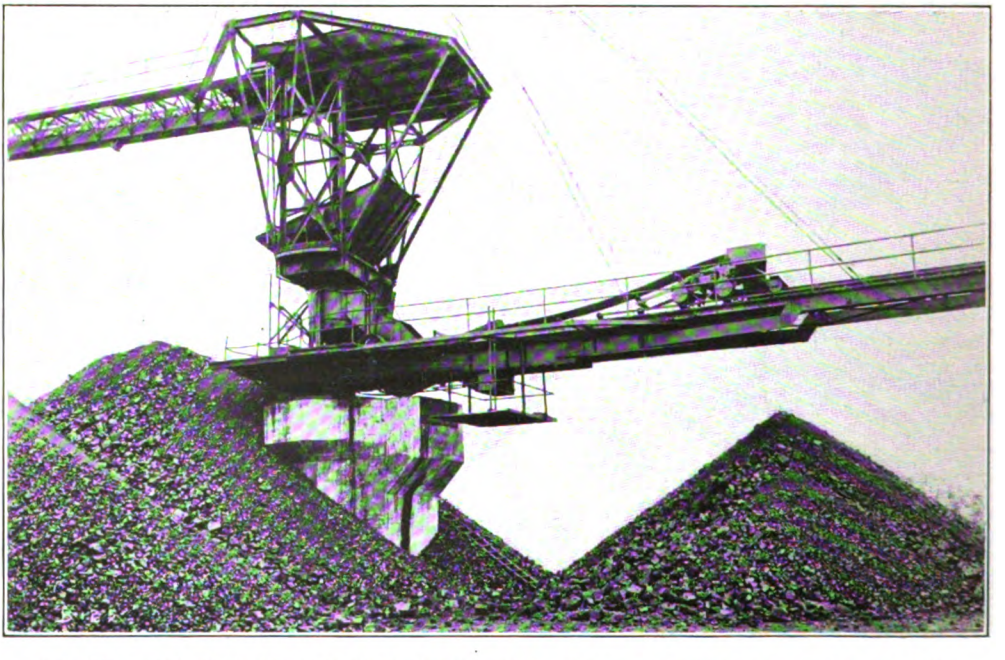

FIG. 13. THE STORING AND RECLAIMING TOWER OF THE PLANT SHOWN IN FIG. 12

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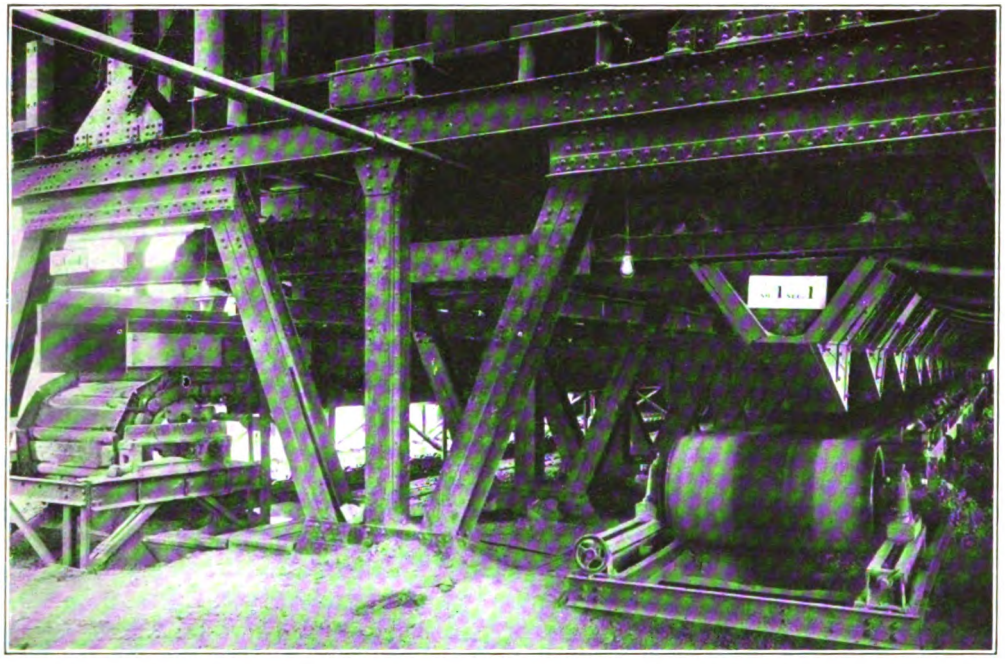

FIG. 14. STEPHEN-ADAMSON PAN AND BELT CONVEYORS WORKING SIDE BY SIDE HANDLING ORE FOR THE UTAH COPPER COMPANY

The belt conveyor carries the smaller ore, up to 4 inches, and the pan conveyor the coarser material. Both are fed by means of cross apron conveyors.

the load on the belt may be found by using a similar formula:

$$\text{Load Horsepower} = \frac{bw_1 VL}{33{,}000}$$

where

b = a constant,

w_1 = weight of load in pounds handled per minute.

The values of the constants (a) and (b) have been determined experimentally, but results obtained do not check well. The value of (a) depends on the width of the belt and is probably about 0.004 w. The constant (b) varies with the weight per cubic foot of material carried, being greater for light materials than for heavier ones. For materials weighing 50 pounds per cubic foot the value of (b) may be taken at from 0.05 to 0.08, and for materials weighing 100 pounds per cubic foot the value of (b) will vary from 0.03 to 0.05.

The formulas given above apply only to horizontal belts. When loads are carried on inclined belts the additional power that must be supplied may be found by the formula

$$\text{Elevating Horsepower} = \frac{2000\ W\ H}{60 \times 33000}$$

where

W = tons of material handled per hour,

H = height to which load is elevated or the difference in elevation between the loading hopper and tripper.

Power must also be supplied for each tripper on the conveyor. This varies with the width of the belt, and

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may be found by the empirical formula

$$\text{Horsepower for each tripper} = \frac{w - 10}{8}$$

where w is the width of the belt in inches.

It is convenient to have tables giving the horsepower required for belts under certain conditions. From these tables horsepowers required for other conditions may be found by simple calculation. Table II gives the horsepower required for belts of different widths, traveling at various speeds, carrying material weighing 100 pounds per cubic foot. Table III gives the same data for belts carrying material weighing 100 pounds per cubic foot. It is interesting to note that the values given in Table III are only 15 per cent higher for the narrow belts and 30 per cent higher for the wide belts than those given in Table II, even though the material carried is 100 per cent heavier. In Table IV is given the additional horsepower required when the belt is inclined.

TABLE II

HORSEPOWERS REQUIRED FOR BELT CONVEYORS, BASED ON HORIZONTAL CONVEYOR 100 FEET CENTER TO CENTER CARRYING MATERIAL WEIGHING 50 LBS. PER CUBIC FOOT

Width of belt, inches	Velocity in feet per minute											H. P. to add for each tripper
	100	150	200	250	300	350	400	450	500	550	600	
12	1.4	1.5	1.6	1.7	1.8	1.9	2.0	...	...	...	...	.5
14	1.4	1.6	1.7	1.8	1.9	2.0	2.1	...	...	...	...	.5
16	1.5	1.6	1.7	1.8	2.0	2.1	2.3	...	...	...	...	.75
18	1.5	1.7	1.8	2.0	2.2	2.3	2.6	2.8	...	...	...	1.0
20	1.6	1.7	1.8	2.1	2.2	2.4	2.7	2.9	...	...	...	1.25
22	1.6	1.8	1.9	2.1	2.3	2.5	2.8	3.0	3.3	...	...	1.50
24	1.8	2.2	2.5	3.0	3.3	3.8	4.0	4.5	5.0	...	...	1.75
30	2.2	2.8	3.3	3.7	4.5	5.2	6.0	6.7	7.5	8.3	...	2.5
36	2.9	3.5	4.5	5.6	6.7	7.8	9.0	10.1	11.2	12.3	...	3.25
42	3.5	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5	...	4.0
48	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.5	24.0	5.0
54	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0	27.5	30.0	6.0

TABLE III

HORSEPOWER REQUIRED FOR BELT CONVEYORS, BASED ON HORIZONTAL CONVEYOR 100 FEET CENTER TO CENTER CARRYING MATERIAL WEIGHING 100 LBS. PER CUBIC FOOT

Width of belt, inches	Velocity in feet per minute											H. P. to add for each tripper
	100	150	200	250	300	350	400	450	500	550	600	
12	1.6	1.7	1.8	1.9	2.1	2.2	2.3	...	...	...	...	.5
14	1.6	1.7	1.9	2.0	2.3	2.4	2.6	...	...	...	...	.5
16	1.7	1.8	2.0	2.1	2.4	2.5	2.8	...	...	...	...	.75
18	1.7	1.8	2.1	2.3	2.5	2.7	3.0	3.2	...	...	...	1.0
20	1.8	1.9	2.2	2.5	2.7	3.0	3.3	3.8	...	...	...	1.25
22	1.8	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.4	...	...	1.50
24	2.1	2.4	3.0	3.5	4.0	4.5	5.2	5.8	6.5	...	...	1.75
30	2.7	3.5	4.2	5.3	6.3	7.4	8.4	9.5	10.5	11.6	...	2.5
36	3.3	4.4	5.8	7.3	8.7	10.2	11.6	13.0	14.5	16.0	...	3.25
42	4.3	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	...	4.0
48	5.2	7.9	10.5	13.1	15.8	18.4	21.0	23.6	26.3	29.0	31.5	5.0
54	6.8	10.2	13.6	17.0	20.4	23.8	27.2	30.6	34.0	37.4	40.8	6.0

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TABLE IV.

ADDITIONAL HORSEPOWER REQUIRED FOR INCLINED BELTS. TO BE ADDED TO HORSEPOWER REQUIRED FOR HORIZONTAL CONVEYOR

Tons per Hour.	Height Material is Raised (in feet)									
	10	20	30	40	50	60	70	80	90	100
10	.10	.20	.30	.40	.50	.60	.70	.80	.90	1.00
15	.15	.30	.45	.60	.75	.90	1.05	1.20	1.35	1.50
20	.20	.40	.60	.80	1.00	1.20	1.40	1.60	1.80	2.00
30	.30	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
40	.40	.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00
50	.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
75	.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50
100	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
150	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50	15.00
200	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00
300	3.00	6.00	9.00	12.00	15.00	18.00	21.00	24.00	27.00	25.00
400	4.00	8.00	12.10	16.10	20.20	24.20	28.20	32.20	36.30	40.30
500	5.00	10.00	15.10	20.10	25.20	30.20	35.20	40.20	45.30	50.30
750	7.40	14.80	22.20	29.60	37.00	44.40	51.80	59.20	66.60	74.00
1000	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

Tables II and III are for belts 100 feet in length. For longer belts the same tables may be used, but the values shown must be multiplied by the length of belt in feet divided by 100.

The driving pulley of a belt conveyor may be one of the end pulleys driven at the proper speed by a belt or motor. When a motor is used, a train of gears is utilized to get the required reduction in speed. Figure

FIG. 15. LINK-BELT CONVEYOR IN THE GROCERY DEPARTMENT OF THE SIEGEL COOPER DEPARTMENT STORE, CHICAGO

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7 illustrates such a drive. In this particular case the motor is geared to the driving pulley through two pairs of gears, one of which is shown in the illustration. The same simple type of drive is shown also in Figure 8, but in this case the power is transmitted to the driving pulley by means of a link belt. In some installations where the operating conditions are very severe two driving pulleys are placed in tandem and the belt passes over both of them, traveling for the instant in the form of the letter S. This drive may be placed at the end of the belt or near the middle. In some cases a tripper may be made use of for this type of drive as shown in Figure 9.

The success of a belt conveyor often depends on conditions that are controlled by the user of the belt rather than by the designing engineer or the manufacturer. One very important point to observe is care in loading. Probably more belts are ruined by careless loading than by any other one cause. Where it is possible the material should come upon the belt in the direction the belt is moving, with little impact, and as near the belt speed as possible. Where the material handled is both coarse and fine, it is well to feed over bars for a short distance, so that the fine stuff will form a bed and protect the belt from impact.

Under certain conditions belt conveyors are not as suitable as some other forms. Thus, for short distances and heavy loads, the chain conveyor is to be preferred. Belts are not suitable either where the material to be handled has sharp cutting edges or where it is hot. As a rule the belt conveyor is not satisfactory where the material must be discharged at many intermediate points, as this multiplies the number of trippers and makes the installation cumbersome and expensive to keep up.

The selection of proper materials that go into the manufacture of belts for conveying purposes is very im-

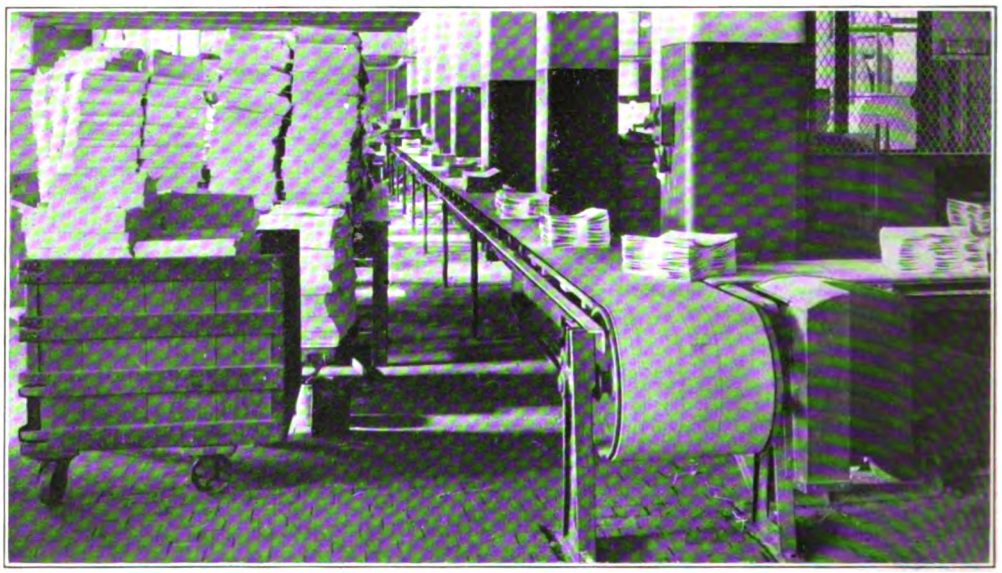

FIG. 16. LINK-BELT CONVEYOR CARRYING SATURDAY EVENING POSTS IN THE PLANT OF THE CURTIS PUBLISHING COMPANY

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FIG. 17. DISPATCHING END OF 12-INCH LAMSON BELT IN THE STETSON HAT FACTORIES
Carrying sweat bands from the leather department to the stiff hat room.

portant. Two kinds of belts are largely used, namely, canvas and rubber, and canvas alone, built up in layers so that the belt is from 3 to 10 plies thick. Often an extra rubber cushion from 1/16 to 1/4 inch in thickness is put on the carrying side of the belt. A belt should conform to the troughing action of the guide pulleys by its own weight. If too stiff it will ride these pulleys, run out of line, and wear at the edges; if too flexible, it will crease longitudinally at the angle of the trough, starting separation of the plies at this point. A thin belt will also tend to flatten between the idlers.

The tension used in belts is important, as is also the diameter of the pulleys. The working tension under ordinary conditions should not exceed 24 pounds per inch of width per ply, which is one-sixteenth of the breaking strength. For temporary installations the tension might run as high as 36 pounds. The diameter of the driving pulley in inches should be at least five times the number of piles in the belt, and in large and important installations this should be increased to seven or eight times the number of plies.

In order to give some idea of the possible uses to which a belt conveyor may be put, several illustrations are shown here. One fertile field for the use of the belt conveyor is in handling bulk material which travels a certain path or route, as does the grain in an elevator. Figure 10 illustrates the distributing system in the head house over the system of storage tanks. In

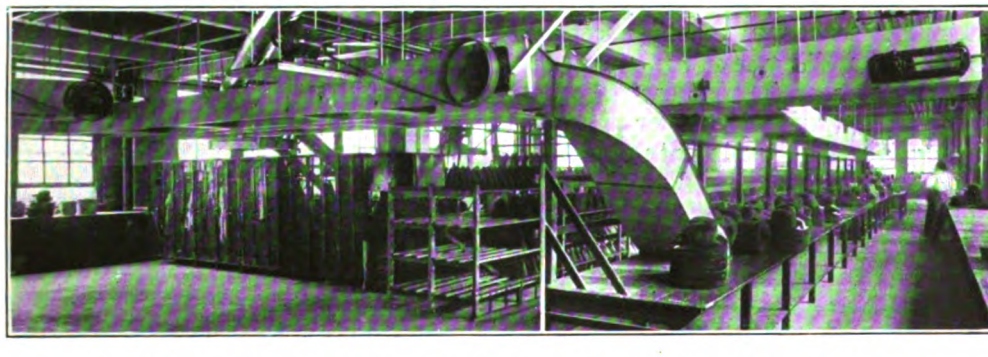

FIG. 18. DELIVERY CHUTE AND RECEIVING TABLES IN THE STETSON FACTORIES
Here the hats are inspected and put back upon the other conveyor which takes them back to the stock room.

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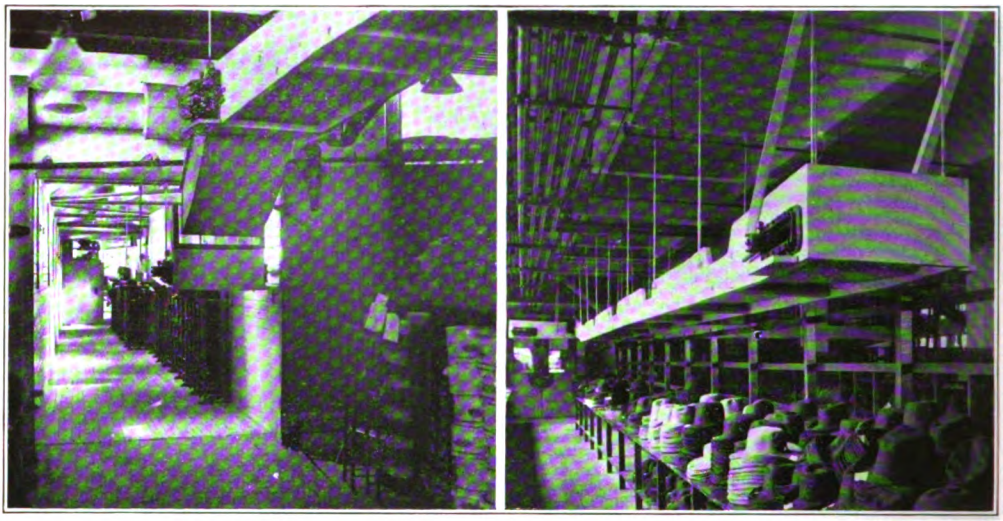

FIGS. 19 AND 20. LAMSON CONVEYORS IN THE STETSON HAT FACTORIES

To the left is shown a peculiar arrangement to allow for the closing of a fire door. The conveyor in one of the buildings ends at the entrance to a connecting bridge between two buildings. Here the hats slide down a chute, across the opening for the fire door, and land on a second conveyor on the bridge At the right is shown the beginning of a 24-inch conveyor upon which hats are thrown from the drier and are carried through four buildings and across two streets.

this particular installation there are three parallel conveyors with movable trippers which distribute the grain into the proper tanks. Underneath these tanks are cross belts which carry the grain to two main belts for delivery to the loading out spouts. This arrangement is shown in Figure 11.

In a manufacturing plant the handling and storage of raw bulk material, such as coal, coke, limestone, or sand, is a very important problem, not only on account of the necessity for such handling, but also in order to keep down an item of cost of what is really unproductive labor. As an illustration of an up-to-date plant for unloading, storing, and reclaiming bulk materials by belt conveyors, Figures 12 and 13 are shown. This plant was built by the Stone and Webster Engineering Corporation for the Fall River Gas Company. The unloading tower, shown at the right in Figure 12, is a full-swing, stiff-legged derrick of steel construction with two independent booms. The upper boom does the unloading and reclaiming, working with a radius of 110 feet, and carrying a 2½-yard grab bucket which takes the coal from barges at the dock, or from storage, and delivers it to a central hopper on the mast. This hopper feeds the coal to a 30-inch belt conveyor on the lower swinging boom, from which it may be discharged into a hopper on top of the storage house or into storage at any radius by means of an automatic tripper. After passing the crusher, the coal is fed to a 24-inch belt conveyor that delivers it to a second conveyor of the same size leading to the retort building, or to another 24-inch conveyor leading to a cylindrical concrete storage bunker. A 24-inch belt underneath this bunker reclaims the coal and carries it to the conveyor running from the crushing house, which in turn delivers it to the retort building.

The unloading and reclaiming crane is electrically operated, one op-

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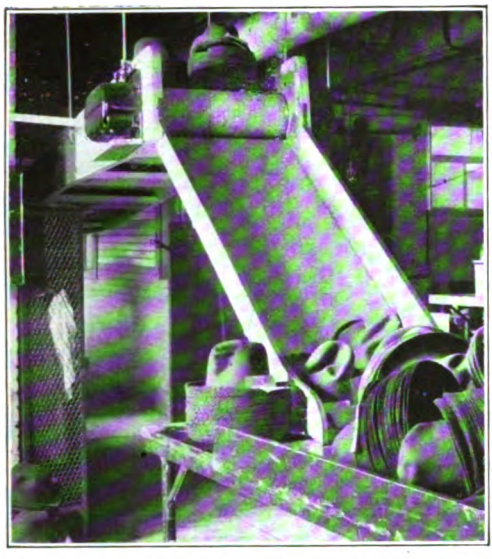

FIG. 21. THE DISCHARGE END OF THE HAT CONVEYOR SHOWN IN FIG. 20

eration in the cab controlling all the movements of the machine. The plant has a nominal capacity of 100 tons per hour. The pillar with the two booms and central hopper is shown in detail by Figure 13.

In Figure 14 is illustrated a plant which bears out the statement made earlier in this paper that under certain conditions some other type of conveyor is more useful than the belt conveyor. This illustration shows a 36-inch belt conveyor and a 48-inch pan conveyor side by side under copper-ore storage bins. These conveyors are fed by the steel apron feeders shown above them. The ore is screened, and the large lumps, up to 18 inches, are taken care of by the pan conveyor, while the smaller lumps, up to 4 inches, are carried by the belt.

It might be inferred from what has been said that the belt conveyor is used only for conveying bulk material. This is not true for there have been many successful installations of such conveyors for carrying packages.

Figure 15 shows a conveyor in the grocery department of Siegel Cooper and Company, Chicago, for carrying light and heavy packages. An entirely different kind of product is handled by the belt shown in Figure 16. This installation is in the publishing house of Curtis Publishing Company in Philadelphia. At the time the photograph was taken the belt was carrying unwrapped lots of the Saturday Evening Post.

In some manufacturing plants where it is necessary for the material to pass from one building to another in process of manufacturing, belts may often be used to a good advantage. One instance of this kind may be found at the Stetson hat factory in Philadelphia, which is equipped with an elaborate system of belt conveyors for handling hats during the process of manufacture. They convey sweat leathers from the leather department

FIG. 22. A WEBSTER FLIGHT CONVEYOR HANDLING AMMONIUM SULPHATE
Lehigh Coke Company, South Bethlehem, Pa.

to the trimmers, unfinished hats to the driers and from the driers to the inspection department, finished hats to the stock department, and unfinished hats and various other materials from the stock department to the finishing departments. Figure 17 shows the dispatching end of the 12-inch conveyor which carries sweat bands from the leather department to

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FIG. 23. CHAIN CONVEYOR FOR HANDLING BOXES, JEFFREY MANUFACTURING COMPANY

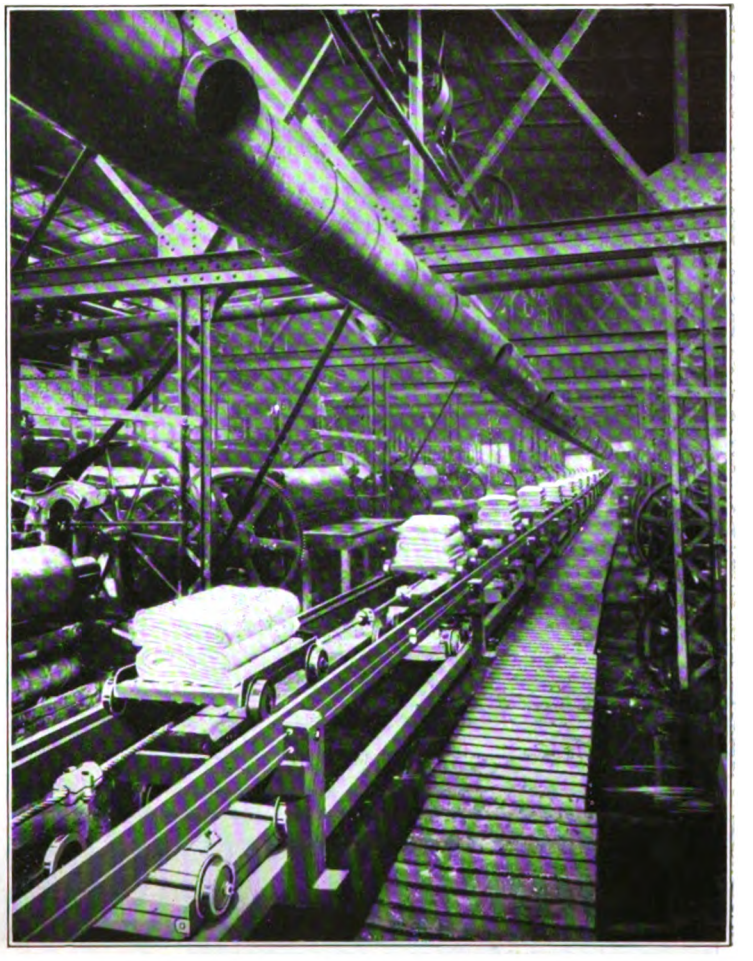

FIG. 24. JEFFREY CONVEYOR COMPOSED OF FOUR-WHEEL TRUCKS CLAMPED TO AN ENDLESS WIRE CABLE HANDLING WOOD PULP

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the stiff hat room on the fourth floor. At the left of the operator is a spiral chute leading to a conveyor directly below which delivers to the soft hat trimming department on the second floor across a street. The delivery ends of these two conveyors drop the sweat bands, which are tied up in bundles, down inclined chutes to sorting tables. Figure 18 shows the chute from a 24-inch conveyor and the receiving tables in the inspection department. The hats are inspected here, put upon the other conveyor shown, and taken back to the stock room. A peculiar arrangement on this conveyor is shown in Figure 19. The hats pass from one building to another by means of a covered bridge. There is a fire door at the entrance to the bridge, and, in order to not interfere with the working of the door, the conveyor terminates in a chute, down which the hats slide and jump across a space left for closing the door. They land on another belt which takes them across the bridge. Figure 20 shows the end of a 24-inch conveyor upon which the hats are thrown as they come from the drier. The soft hats are taken through four buildings and across two streets by this conveyor which terminates as shown in Figure 21.

Flight Conveyors

One of the oldest types of conveyors consists of an endless chain to which are bolted at intervals scrapers of various forms which drag the material along in a trough. The simplest form of this conveyor is that in which a cable is utilized in place of a chain and cast iron buttons are bolted to a cable traveling in the bottom of a V-shaped trough. This type of conveyor is particularly useful in taking care of waste material of various sizes, such as saw mill refuse.

A higher type of flight conveyor is that in which there are two chains which carry flights or scrapers between them. These chains are often made up of flat bars for links. Two bars are placed side by side with a roller or small wheel between them running on flat rails. Naturally this arrangement helps to keep the friction down to a minimum. Such a conveyor is illustrated in Figure 22, which shows a Webster machine installed by the Didier-March Company for the Lehigh Coke Company of South Bethlehem, Pennsylvania. The material handled is ammonium sulphate, a by-product of the coke ovens. This sulphate is taken from the driers by a smaller transverse conveyor and delivered to a hopper which feeds the main conveyor shown in the illustration. During the first 50 feet, the conveyor rises at an angle of 37 degrees with the horizontal, attaining a height of 35 feet at the point of entry into the salt house just beneath the roof. Inside the salt house, where the conveyor is suspended from the roof trusses, it has a straight travel of about 180 feet. Gated openings at intervals in the trough provide means of distribution from one end of the house to the other. The flights are 16 inches wide and 6 inches deep, their ends being riveted to attachment links in the roller chain.

The speed of flight conveyors varies from 100 to 200 feet per minute, the lower speeds being used with coarse and the higher with fine materials. The capacity depends, naturally, on the size and spacing of the flights. Table V, on the following page, gives the capacities in tons per hour of conveyors traveling at a speed of 100 feet per minute with a load weighing 100 pounds per cubic foot.

There are many modified forms of flight or chain conveyors used for specific purposes. One of these is illustrated in Figure 23. Here three

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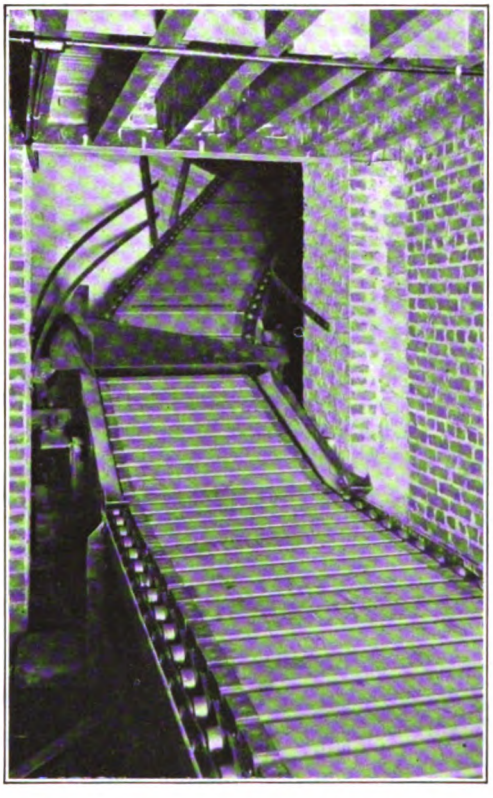

FIG. 25. JUNCTION OF TWO WEBSTER APRON CONVEYORS
Plant of Johnson and Johnson, New Brunswick, N.J.

TABLE V
CAPACITIES OF HORIZONTAL FLIGHT CONVEYORS

Size of Flights, Inches	Flights Spaced			
	12 inch	16 inch	18 inch	24 inch
4 x 10	90	67	60	45
4 x 12	114	85	76	57
5 x 12	138	103	92	69
5 x 15	186	139	124	93
6 x 18	240	180	160	120
8 x 18	360	270	240	180
8 x 20	420	315	280	210
8 x 24	540	405	360	270

chains, running in grooves and having dogs attached at intervals by means of bolts, are used for pushing packing cases along on steel strips secured to the floor. Another, shown in Figure 24, is made up of small four-wheel trucks or pans fastened to a steel cable by means of cast iron spools. This type of conveyor is particularly adapted for long distance hauls. In the case illustrated, the haul is 750 feet, the material, wood pulp on the way from machines to storage rooms.

APRON CONVEYORS

This type of conveyor is made up of two chains placed from 24 to 48 inches apart, with steel or hardwood "aprons" or pans bolted to the chains, so that the conveyor is practically a continuous flexible platform. The combined chains and aprons are carried on wheels or rollers running on steel rails. There are two wheels or rollers for each cross member or apron, one at either end. This type of conveyor is used for carrying package material or bulk material in large lumps. To show the application of the apron conveyor, a description will be given of one recently installed by the Webster Manufacturing Company at the plant of Johnson and Johnson at New Brunswick, N. J. This conveyor carries boxed goods from a packing room, out across an open space and a canal, through a long building, and into a shipping department on the water front. The packing room is in the second story; the shipping room on the ground level. Furthermore, the shipping room is not directly opposite the packing room but in a diagonal direction. Thus the conveyor is in two sections, one diagonal and the other direct. The conveyor leaves the shipping room and crosses the canal about twenty feet above the ground level for a distance of 60 feet. It then dips down to the basement of the building through which it must pass to reach the shipping room. At the bottom of the incline in the basement just mentioned the diagonal conveyor, which

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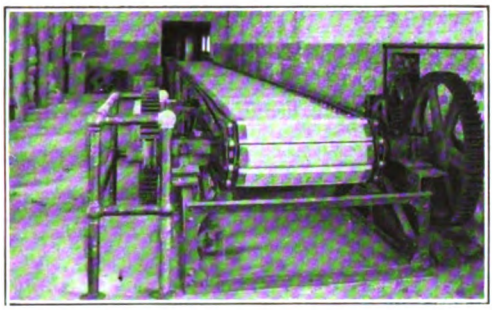

FIG. 26. THE DRIVE OF THE TWO SECTIONS OF WEBSTER APRON CONVEYORS
Plant of Johnson and Johnson

is 135 feet between centers, ends and the direct conveyor begins. Between the two is an angle plate over which the boxes slide to the direct conveyor, as shown in Figure 25. This direct conveyor is 210 feet long, making a length between centers of 445 feet for the total installation.

The conveyor is 36 inches wide, made up of 1½ by 5¾ inch hard maple slats, attached to two strands of 6-inch malleable-iron roller-chain. The diagonal and straight sections are coupled together by a combination bevel-gear and chain drive. Thus the motor in the packing room drives both sections. This drive is illustrated in Figure 26. Both ends of each conveyor having fixed centers, take-up provisions are made at convenient points on the return runs. Figure 27 shows this take-up on the return of the straight conveyor in the basement of the warehouse which it traverses.

The apron conveyor may be used on steep inclines, but in such installations it is necessary to put cleats on the aprons at intervals to prevent the packages from sliding. Such a conveyor is illustrated in Figure 28, an installation by the Jeffrey Manufacturing Company in the Municipal Filtration Plant, Columbus, Ohio.

Even though the apron type is necessarily a heavy installation, it may be used as a portable machine to advantage in some cases. The Alvey-Ferguson Company has made such an installation for the Anheuser-Busch Brewing Association of St. Louis, as shown in Figure 29. This conveyor receives bags of rice at the entrance of a large store room and carries them into storage. It is also used for carrying the bags from the store room to other departments.

This type of conveyor is well adapted to use in short sections for transferring work from one room to another, or from one machine to another. Figure 30 illustrates a short length of Jeffrey pipe flight-apron conveyor transferring boxes from a machine to an adjoining room, while Figure 31 shows a wood-apron platform conveyor taking men with trucks and freight direct from warehouse into a boat. This conveyor is adjustable to suit tide conditions and may also be used for conveying from warehouse up into freight cars.

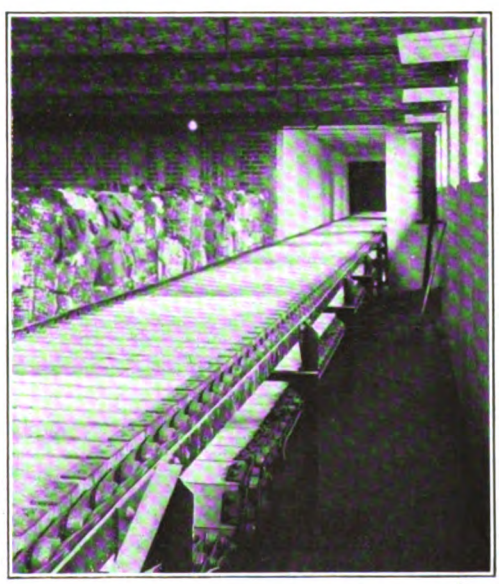

FIG. 27. THE BASEMENT SECTION SHOWING TAKE-UP OF THE APRON CONVEYOR SHOWN IN FIGS. 25 AND 26

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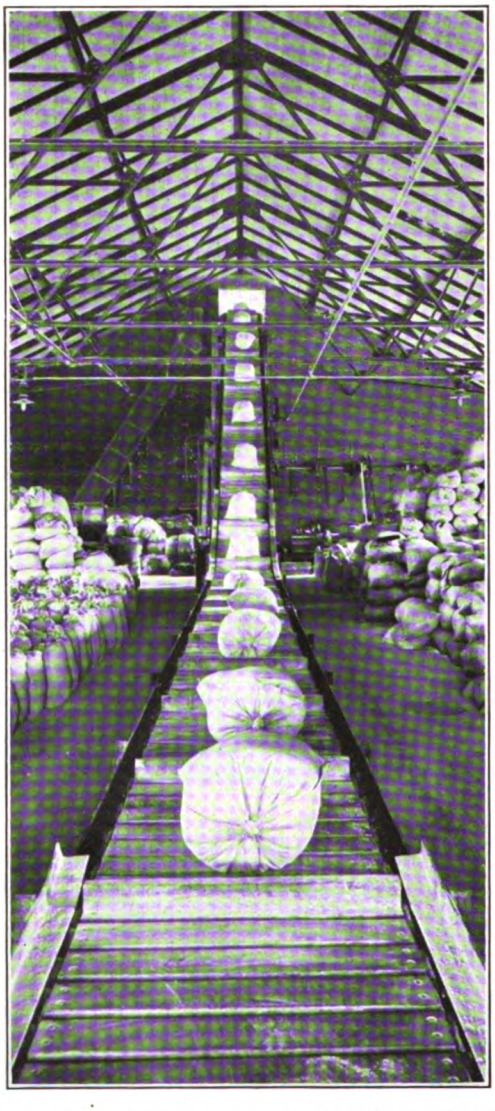

FIG. 28. JEFFREY APRON CONVEYOR WITH EXTRA CROSS BARS FOR USE ON STEEP INCLINES

Bucket Conveyors

All types of conveyors so far considered in this article have one serious drawback: they are not well adapted t elevating material except at small inclinations to the horizontal. Flight conveyors, belt conveyors, apron conveyors, and even screw conveyors are used to some extent for elevating material, but the space required to get the small angle necessary often makes it impossible to use any of these types. In such cases a bucket conveyor may be used to a good advantage, as this type carries its load equally well at any angle from the horizontal to the vertical. This type is composed of a succession of small buckets attached to endless chains or belts running over pulleys or sprockets, so that the buckets form an endless procession.

One of the earlier types of the bucket conveyor consisted of a series of pressed steel buckets riveted to a leather or rubber belt. Obviously this type could be used only for vertical or nearly vertical elevation. The most common type in use today consists of a series of steel buckets, of the same general shape but larger than those used with belts, pivoted between two endless chains which are carried on rollers or wheels running on steel rails when the direction is anything but vertical. As the buckets at all times maintain their carrying position by gravity, a single conveyor can transport material horizontally, vertically, or at any desired angle.

These bucket conveyors have several advantages:

1. The material is carried on rollers or wheels, so that friction is not great, there is no injury to the material itself, and power required is reduced to a minimum.

2. The ability of one machine to elevate and convey avoids transfers, which are always troublesome and take up valuable space.

3. The material is readily discharged at any point.

4. The operation is silent, as the conveyors are run at low speed and there is no vibration.

The bucket and chain conveyor of the present is so arranged that the buckets overlap to a certain extent to prevent the material falling between

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FIG. 29. ALVEY-FERGUSON PORTABLE APRON CONVEYOR IN PLANT OF ANHEUSER-BUSCH BREWING ASSOCIATION, ST. LOUIS

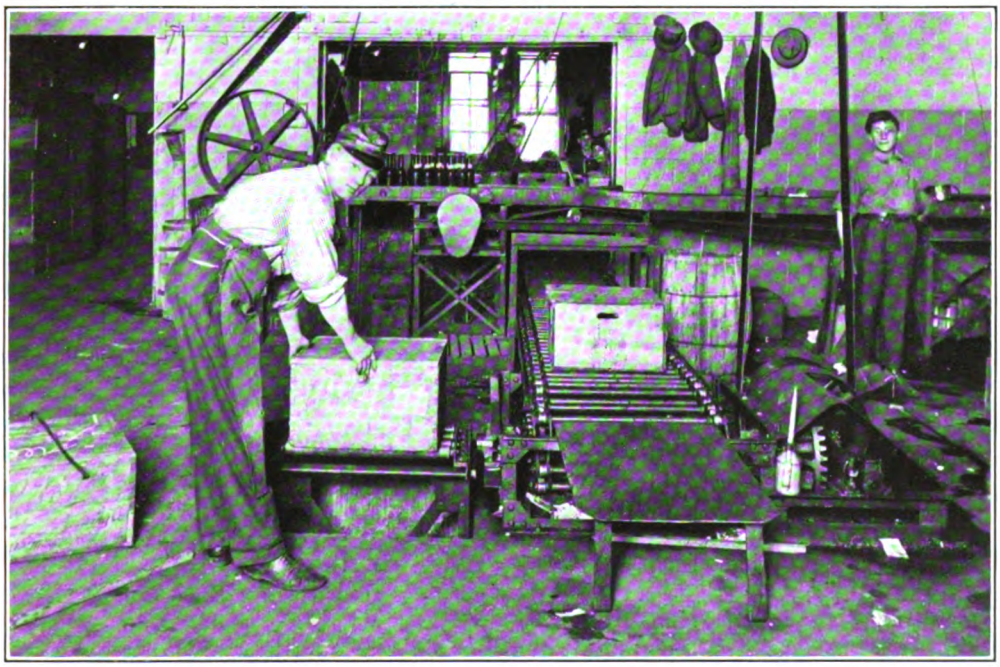

FIG. 30. JEFFREY PIPE FLIGHT-APRON CONVEYOR HANDLING BOXES OF BOTTLES FROM MACHINE TO ADJOINING ROOM

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FIG. 31. JEFFREY APRON CONVEYOR
Carrying men, trucks, and freight between freight house and vessel, in either direction, depending on the tide.

the buckets at the loading points. While it is not difficult to take care of this overlapping in straightaway carriers, it is difficult to prevent interference when the conveyor goes around sprockets. Thus, as a conveyor changes from a vertical to a horizontal run, each bucket will be overlapped by the one following, and if there is no means used to prevent this, trouble will arise when these buckets change again from the horizontal to the vertical run. There are several methods used to correct this. One method is to use a tilting device which makes each bucket overlap the following one when the conveyor runs over a sprocket in changing from a vertical to a horizontal run. Then the buckets run naturally from the horizontal to a vertical run.

The system used by the Link-Belt Company to overcome the interference at sprockets, is to suspend the buckets from extensions of the inner links beyond the chain joints, so that in passing around the corner wheels or sprockets they travel on a larger circle than the chains. Thus the buckets are automatically separated at the turns and there is no interference no matter which way the buckets are lapped on the horizontal run. In this way a loaded bucket can make a complete circuit of the conveyor system without discharging its load.

The bucket conveyor is installed only where the elevating part of the carrying proposition is of importance, that is, where part of the work is horizontal and part vertical. If the elevating can be done by means of a gradual incline, a belt conveyor may be used in most cases, but where part of the run must be in a vertical direction, the bucket conveyor is the only feasible proposition. The usual bucket conveyor system, then, consists of at least two horizontal and two vertical runs. The driving mechanism is usually put at one of the corners. Figure 32 shows a typical drive; a pair of sprockets, one for either chain, driven by a belt through two pairs of spur gears to get the proper reduction in speed. At the

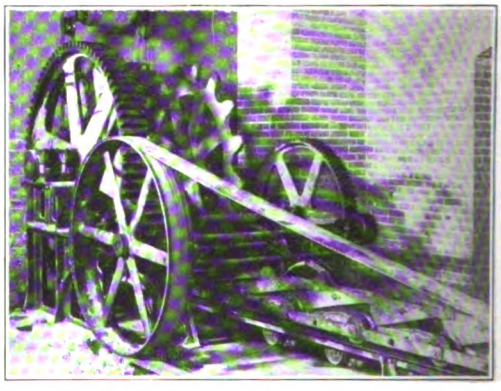

FIG. 32. DRIVING GEARS OF JEFFREY BUCKET CONVEYORS

other corners plain sprockets are used as idlers, as illustrated in Figure 33.

An interesting installation, and one that shows the peculiar fitness of the bucket conveyor for certain classes of work, is illustrated in Figure 34. This is one of two Perkins bucket carriers erected by the Webster Manufacturing Company at the plant of the Ogden Portland Cement Com-

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pany, Brigham City, Utah. As the cement clinker comes out almost white hot from the rotary kilns it drops into the lower horizontal run of one of the conveyors, is carried outside the kiln building, and then elevated to a proper height for spouting into the upper end of a 3 by 64-foot rotary cooler. From this cooler the clinker falls into the second bucket conveyor, the one illustrated, which elevates it to the top of the finish-grinding building.

Figure 35 shows another cement

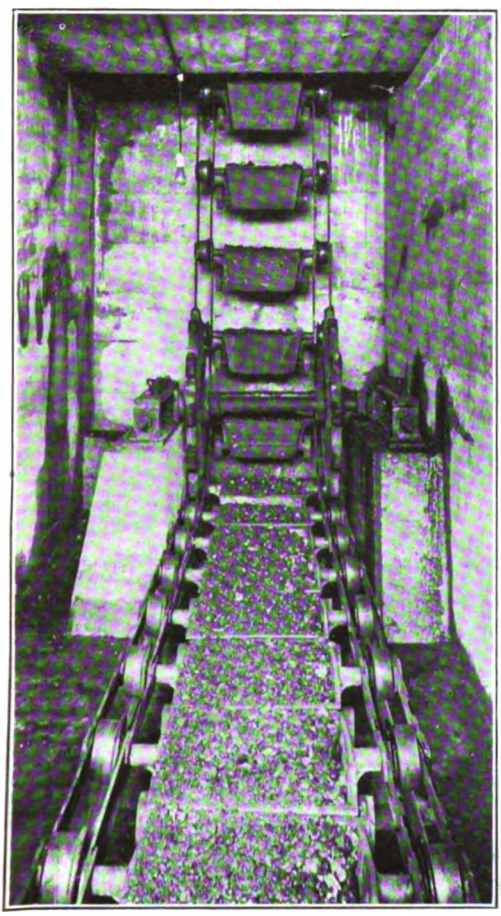

FIG. 33. PLAIN IDLER SPROCKETS AT CORNER OF JEFFREY BUCKET CONVEYOR

This illustrates clearly how the loaded buckets retain their horizontal positions even on the vertical run of the conveyor.

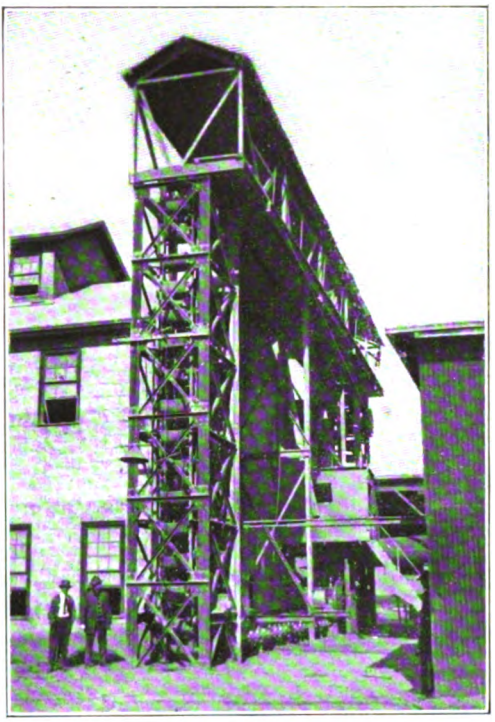

FIG. 34. PERKINS BUCKET CARRIER

Erected by the Webster Manufacturing Company at the Brigham City plant of the Ogden Portland Cement Company. This conveyor takes the clinker from the rotary coolers and elevates it to the top of the finish grinding building whence it runs by by gravity to the mills.

installation, a Peck carrier installed by the Link-Belt Company in the plant of the Great Western Portland Cement Company, Mildred, Kansas. This conveyor is 231 feet long and 42 feet high. The bottom horizontal run is through a solid reinforced concrete tunnel.

Two Peck carriers in the plant of the Hainesport Mining Company of Philadelphia are shown in Figure 36. The lower rails inside the brackets which support the conveyor proper are the rails which carry the discharger. This machine may be moved to any position along the upper horizontal run of the conveyor so that the load may be discharged at any point. Figure 37 illustrates the action of this discharger. Cams on the side of the

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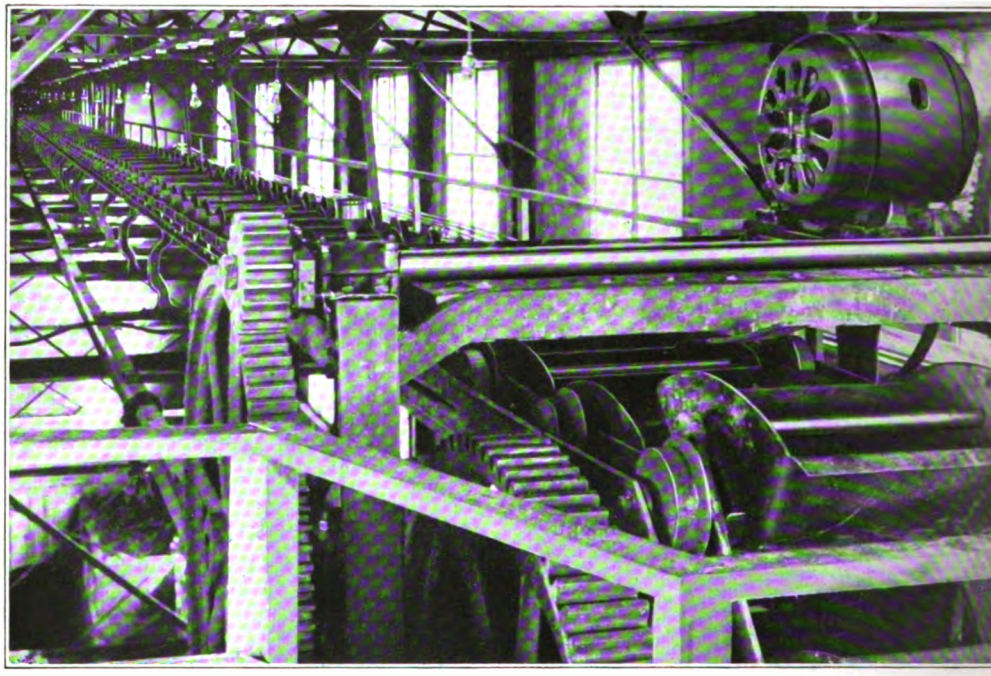

FIG. 35. PECK CARRIER INSTALLED BY THE LINK-BELT COMPANY IN THE MILDRED, KANSAS, PLANT OF THE GREAT WESTERN PORTLAND CEMENT COMPANY

FIG. 36. TWO PECK CARRIERS HANDLING GRAVEL AND STONE IN THE PLANT OF THE HAINESPORT MINING COMPANY OF PHILADELPHIA

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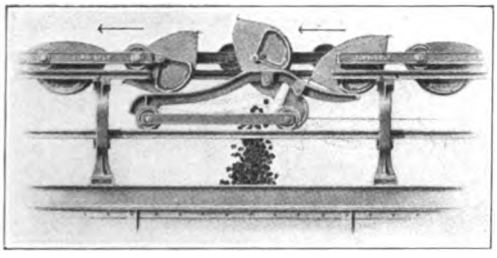


FIG. 37. DIAGRAM OF THE TRIPPER OR DISCHARGER USED WITH THE PECK CARRIER MADE BY THE LINK-BELT COMPANY

buckets engage the curve of the discharger which has such a form that the contact is a rolling one, without friction or noise. There are three types of dischargers used: the fixed type, which may be dropped to an inoperative position, as shown by the dotted lines in Figure 37; the movable type, which may be set by means of a hand winch to operate at any desired point; and the automatic type, which has a slow, continuous travel, automatically reversing at the ends of the path.

The carrier itself runs on tee-rails which, as shown in Figure 37, are supported by cast-iron chairs set on the floor along the lower run. Channel irons carry the chairs on the upper run, and the discharger travels over rails supported by these chairs. Ample clearance is provided beneath the buckets on the lower run to prevent any interference. In vertical runs swaying is prevented by providing guide rails in front and back of the rollers.

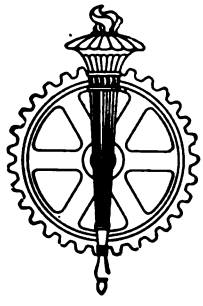
To give some idea of the size and capacity of bucket conveyors Table VI is given here. This shows the sizes manufactured by the Link-Belt Company of Chicago.

TABLE VI

SIZE AND CAPACITY OF PECK BUCKET CARRIERS

Bucket, inches	Pitch of Chain, inches	Carrying Capacity of Bucket in Cu. Ft.	Capacity of Coal —Tons Per Hour	Speed Ft. Per Minute
18 x 15	18	0.68	15- 20	30-40
18 x 21	18	0.94	20- 30	30-40
24 x 18	24	1.68	40- 50	40-50
24 x 24	24	2.24	55- 70	40-50
24 x 30	24	2.80	75-100	40-50
24 x 36	24	3.36	90-120	40-50
30 x 24	30	3.50	95-120	45-60
30 x 30	30	4.37	110-160	45-60
30 x 36	30	5.25	140-190	45-60
36 x 36	36	8.50	210-330	50-80

To be continued



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TRAFFIC CONGESTION WHICH THE MOTOR TRUCK WILL ELIMINATE

MOTOR TRUCKS AFTER THE WAR

By Rollin W. Hutchinson, Jr.

We asked Mr. Hutchinson, What will be the future of the motor truck industry when orders from the warring European governments cease? How will prices be affected? What improvements in design and construction are being made? What steps are the manufacturers taking toward developing markets in times of peace? and, What are our chances in foreign countries? His answers to these questions are given in text and picture.—THE EDITORS.

EMERSON'S Twelve Principles of Efficiency may be reduced to a summary expressed in an old business saw that *the most important element in success is economy—economy of money and time.* In the Great War there has been no conspicuous effort to economize in money, but there have been more or less determined attempts to economize in time. For instance, in the history-making days of late August, 1914, when the Germans were bearing down upon Paris at the rate of forty to fifty miles per day, the sapient Teutons were essaying to economize in *time* and *money* by capturing Paris, then London, then making a bold dash for the Eastern front and annihilating the Russians.

One of the foremost factors in the German scheme of economizing in time was the automobile truck which was the chief vehicle that made it practicable for the unprecedented mobility of the German armies. The German military engineers in this extraordinary burst of speed were endeavoring to apply that business aphorism quoted above, and without the motor truck as their chief ally would not have succeeded as well as they did. The motor truck has been one of the chief agencies employed in making the Great War so frightfully destructive and efficient in the military sense, and thereby bearing out its province in the commerce of economy—"economy of both money and time."

The American motor truck industry has benefited to a greater extent from the Great War than perhaps any other industry making a machine heretofore regarded as purely a product of business utility. In THE ENGINEERING MAGAZINE for October and November, 1914, the author discussed in some detail the applications of motor trucks in warfare. These articles

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pointed out the fact that the Great War waged without motor trucks as transports would cost the belligerents many millions more per day than the already prodigious expenditures. Recognizing this in the initial stages, not only the quadruple Entente but also the Central Powers immediately commandeered every subsidized and "approved" motor truck factory within their confines, with the result that today every automobile truck factory in Great Britain, France, Germany, Italy, and Austria is a "controlled" institution. The Allied Governments have been in a much more favorable position for obtaining adequate supplies of motor trucks than have the Central Powers, because Germany and Austria, for the reasons pointed out in the articles referred to, have not developed a motor truck industry to the extent that France and Great Britain have; and both of these countries were entirely dependent for their motor military transports on home production and the motor truck factories of Switzerland.

Controlling the seas, the Allies have no difficulty in getting all the trucks they can pay for in the United States, and while a relatively large number of motor cars and trucks shipped to Norway and Sweden in the early months of the war ultimately found their way to Germany (a few even went through the Italian ports to the Central Powers), Germany has been excluded as a foreign buyer except in the Swiss market. Switzerland, while noted for the excellence of its truck products, is a comparatively small producer, although very authentic reports state that the Swiss manufacturers have supplied Germany and Austria with from 3,000 to 6,000 motor trucks the first year of the War. As Switzerland is dependent upon outside sources for most of the raw materials entering into the manufacture of motor trucks, these materials have been supplied almost entirely by Germany. Without the assistance of the Swiss manufacturers and the fact that the deadlock on the Western front for many months enabled the withdrawal of a large number of motor truck transports for the Russian campaign, German armies could not have penetrated as far into Russia as they did during the months of July and August.

The bearing which this discussion of the activity in the European truck industry has, is to show the immense stimulus to the motor truck industry of the world from the Great War, and the percentage which American truck business with the belligerents compares to the total estimated purchases of motor trucks since the war began.

It is reported by competent authority that from August, 1914, to August, 1915, the British Government purchased from home manufacturers 5,000 motor trucks, valued at approximately $15,000,000; the French Government from native builders, 3,000 motor trucks, valued at approximately $8,000,000; the German and Austrian Governments are reported as having invested $12,500,000 in motor trucks from home manufacturers and from Switzerland; the Russian Government is said to have bought from British manufacturers during the first year of the war $1,500,000 worth of motor trucks; and the Italian Government from the Italian manufacturers more than a million. The aggregate valuation of motor trucks bought by the European belligerents in Europe itself would thus total the enormous sum of $38,500,000. But it is $22,000,000 less than the Allied Governments *alone* bought from American (United States and Canadian) truck manufacturers.

In the Government's fiscal year,

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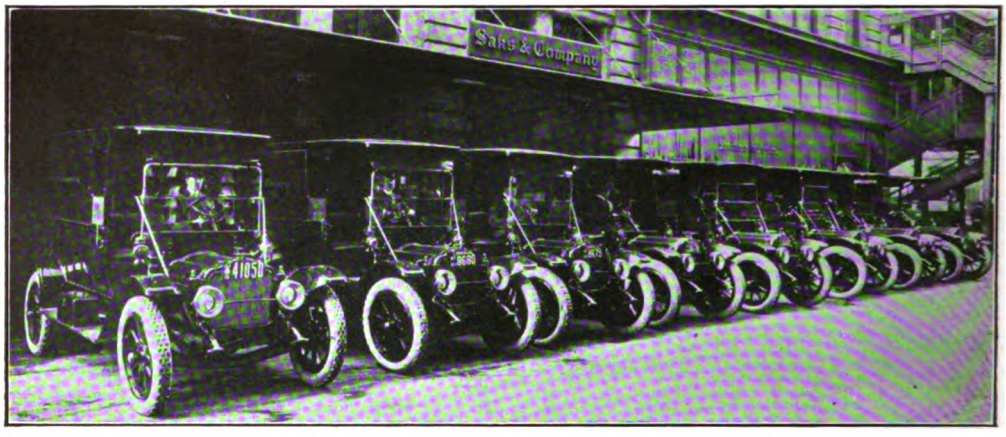

AN INTERESTING EXAMPLE OF THE APPROACH OF UNIVERSAL MOTORIZING IN DELIVERY SYSTEMS OF DEPARTMENT STORES

June, 1914, to June, 1915, the exports of motor trucks were 13,996 machines, valued at $39,140,682. From July 1, 1915, to October 1, 1915, approximately $21,000,000 worth of American trucks were exported to Europe, making a grand total of nearly $60,000,000 so far invested by European nations in fifteen months. In the week ending September 18, 1915, alone, $1,488,786 worth of motor trucks left the port of New York. In the month of July, 1914, but fifty trucks valued at $106,400 were exported. In July, 1915, 2,469 trucks valued at $6,803,000 were exported; the increase the corresponding month in 1915 being over *forty-nine fold* numerically and *sixty-four fold* in a monetary sense. As a contrast and to emphasize the stimulus of the Great War upon the American truck industry, the total number of trucks exported in the fiscal year ending June 30, 1914, was but 784 valued at $1,181,611. Thus the exports for July, 1915, are over three times as great as for the entire year of 1914.

THE TRUCK TRAILER IDEA APPLIED TO MERCANTILE BUSINESS. BOTH TRUCK AND TRAILER ARE OF 5-TON CAPACITY

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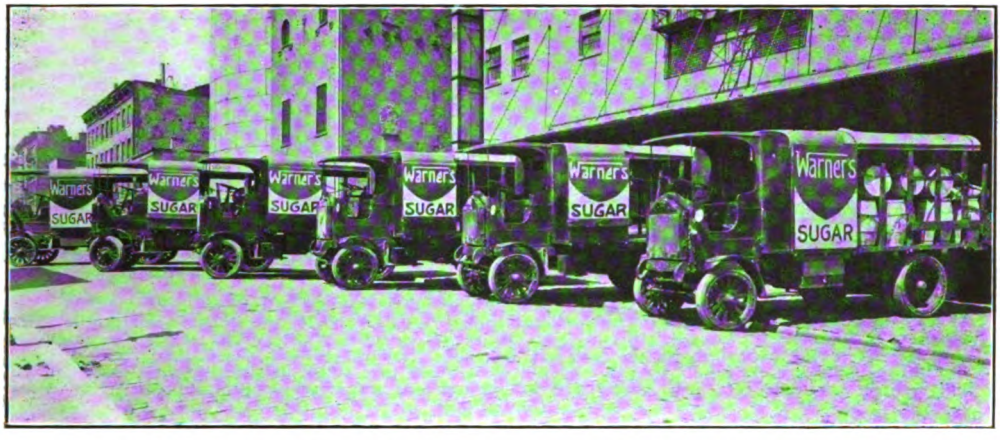

A FLEET OF 7-TON TRUCKS OWNED BY A LARGE SUGAR REFINER IN ONE CITY

The Great War has initiated what will prove to those manufacturers, who are preparing to take advantage of it, the *real beginning* of an unprecedented and greater era of popularity and prosperity than was ever predicted by the most sanguine prognosticators. In several noteworthy respects the influence of a foreign demand has stimulated greatly needed betterments in product, production methods, and selling policies. As each one of these factors has its greater or lesser bearing upon the exceptional activity now prevailing in the American motor truck industry, each will be concisely discussed in order to present a more comprehensive and clear analysis of the past and probable future development of the industry.

In the order of their importance, changes for the better in the motor truck industry directly or indirectly traceable to the prosperity caused by the Great War are:

1. Improved design in product.
2. Improved methods in manufacturing.
3. More intelligent merchandising.

IN CITIES THE DELIVERY OF LARGE QUANTITIES OF COAL BY MOTOR TRUCKS CAN BE MADE MORE ECONOMICALLY THAN WITH 2-HORSE AND 3-HORSE WAGONS

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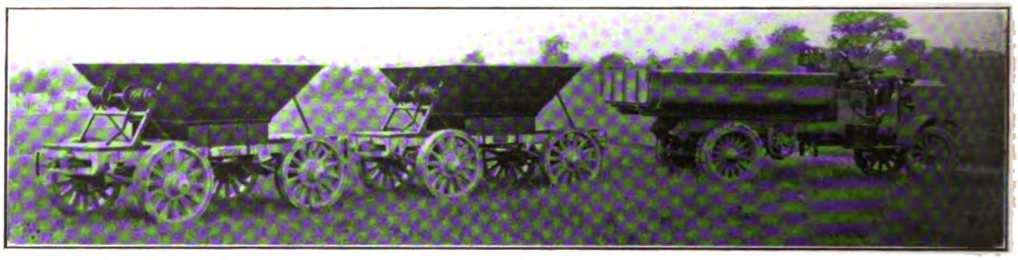


A 5-TON TRUCK HAULING 15 TONS OF CRUSHED STONE FOR A ROAD CONTRACTOR

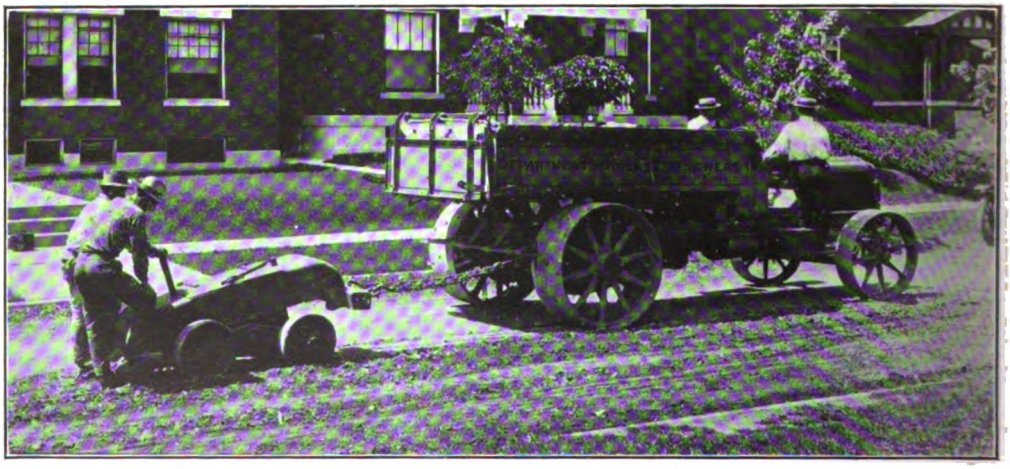
The traction train idea is making greater headway in contracting industries than in mercantile lines because the ordinances of many cities prohibit their use in urban traffic. The above illustration is especially interesting in that the driver can, with automatic loading facilities, load and unload both truck and trailers. Many users have found that operating the truck as a single unit may cost 10 cents per ton mile, towing one trailer of equal capacty 7 cents per ton mile, two trailers of equal capacity 4½ cents per ton mile

4. Tendencies towards larger price reductions incident to increased output.

EFFECTS UPON DESIGN

In mechanical progress in design lies one of the most notable influences of the Great War. It must be candidly stated that for two years preceding the war the motor truck industry had suffered from a serious depression; failure after failure was recorded both among motor truck manufacturers and motor truck merchants. The motor truck business had been greatly overdone for the actual marketing possibilities incident to actual belief in the motor truck by the business public and its acceptance as the successor to the horse for hauling. Many thousands of dollars had been expended in printer's ink to inculcate this conviction, and while the educational work done by manufacturers, aided and abetted by a liberal donation of "white space" by newspapers and industrial magazines, had accomplished considerable in instilling the motor truck method as the correct method in merchants' minds —still the motor truck industry languished.

Hardly a baker's dozen of the 335 manufacturers listed in the 1913 trade journal annuals and advertising



A GOOD ROADS TRUCK SCARIFYING A MACADAM STREET IN ST. LOUIS

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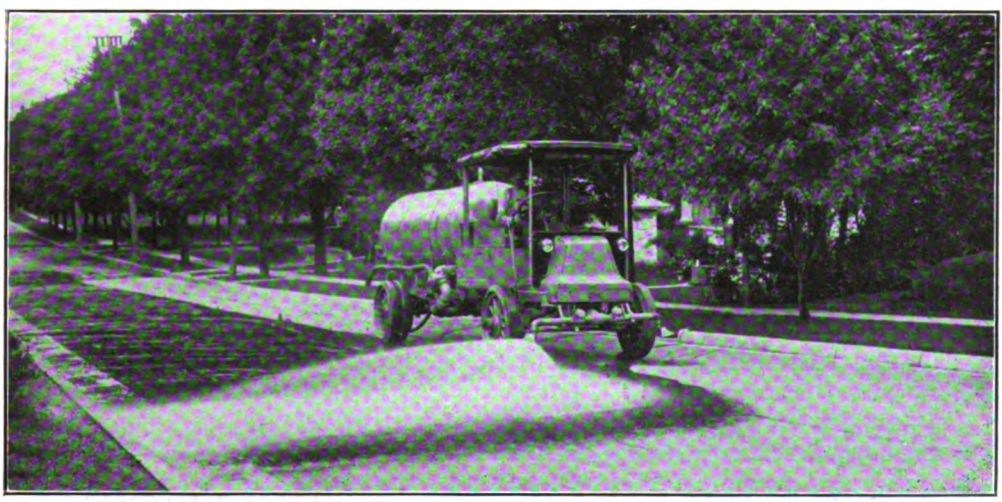
ROAD SPRINKLERS AND OILERS OF TODAY

The growth of motorized sanitary equipment and vehicles this past year has been phenomenal. Official reports from city departments and county governments using these trucks state that one 1200-gallon tank saves $20 to $40 per day over equivalent service rendered by horse-drawn vehicles. A single truck of that capacity replaces in some cases as many as fifteen 2 horse tank wagons

as either building or intending to build business motor vehicles, had really made any money, and not more than ten or twelve had ever declared a semblance of a dividend. Of the actual 35 or 40 in August, 1914, that were not near-moribund, representing larger companies to whom motor trucks were an outgrowth or a "wished on" branch of their passenger car business, there were less than six producing the highest quality motor truck.

In a word, the majority of truck manufacturers in the United States, because of the public's lack of appreciation of the motor truck as *the modern transportation agency*, were compelled to cling to designs that in most cases had hardly been improved since the time the majority of them started in business in 1908 or 1909. Thus, hands were tied; the existing designs could not be scrapped as that would have involved the loss of considerable quantities of material on handed needed for filling current contracts. It must be stated that, while not modern in the comparative sense, most of the representative makes of motor trucks were sufficiently modern to give profitable service and, when used even with the intelligence displayed in managing horse hauling systems, they invariably excelled the horse method in tonnage moved or money saved.



ELECTRIC COMBINATION FLUSHER SPRINKLER OPERATED UNDER PRESSURE

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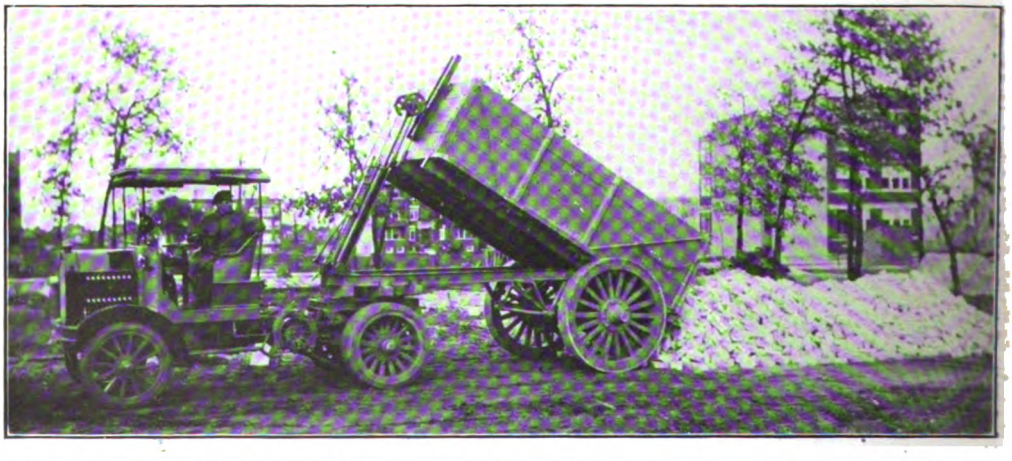
A 5-TON GOOD ROADS TRUCK OF UNIQUE DESIGN

The steel wheels are 16 inches wide in front and 20 inches in rear; the object of such wide wheels is to permit the use of trucks on soft and boggy roads as well as to permit the elimination of steam rollers in road construction. This view shows a truck delivering broken road ballast and tamping down the ballast already laid

But the Great War inaugurated a new era in American motor truck design.

When England, France, and Russia began to send buyers to the States in the Fall of 1914, and when, within a few months, stocks of materials sufficient for building 10,000 motor trucks had all been made up into the *ancient* models then current, truck manufacturers saw the opportunity, which many of the progressive engineers in their employ had seen several years before, to modernize their motor truck product in design, so that it would possess every approved feature already possessed, with more or less modifications, by the passenger motor vehicle. The result has been that designing engineers have been able to produce a far superior design to that which generally prevailed up to the year 1915; and the product of the most progressive manufacturers for 1916 is as far advanced comparatively as the 1916 passenger motor car is to the 1907 car. It is not the province of this article to discuss motor truck design, but the improvements effected. These consist, briefly, in simplifying



THE 6-WHEELED MOTOR TRUCK WHICH HAS DEVELOPED SO RAPIDLY IN HEAVY DUTY HAULAGE. THIS SEMI-TRACTOR TRUCK HANDLES FROM 10 TO 30 TONS ON SOLID TIRES

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A 3-TON MOTOR TRUCK PULLING A GANG PLOW ON A WHEAT FARM IN THE CENTRAL WEST
The modern business farmer is realizing that motor trucks can be made to do everything and cut down labor costs more than mule power, as well as give increased efficiency in farming operations

the mechanism, in approximating at least fool-proof and trouble-proof qualities, in facilitating operation in the hands of unskilled drivers, and in establishing a new conception of what a motor truck should cost to perform a given service in tons, ton-miles, package miles, or whatever basis of measuring unit may be used.

Effects Upon Manufacture

As is to be expected, the radical change in a number of factories from a volume output of a few hundred trucks per year to, in some cases, an increase of a hundred or even a thousand per cent must coincidently bring with it the discarding of the rule-of-thumb, haphazard *man-production* for modern systems in *machine production*, cost accounting, and many other well-known methods of modern and scientific management which were formerly almost unknown in some of the larger truck factories. Today, one can go to truck factories and find a close approximation to the well-established manufacturing methods that have produced conspicuous suc-

PURVEYING AGRICULTURAL PRODUCTS FROM FARMER TO CONSUMER
The owner of this 1½-ton machine, a farmer and wholesale lumberman, uses it for haying, plowing, and all manner of farm work

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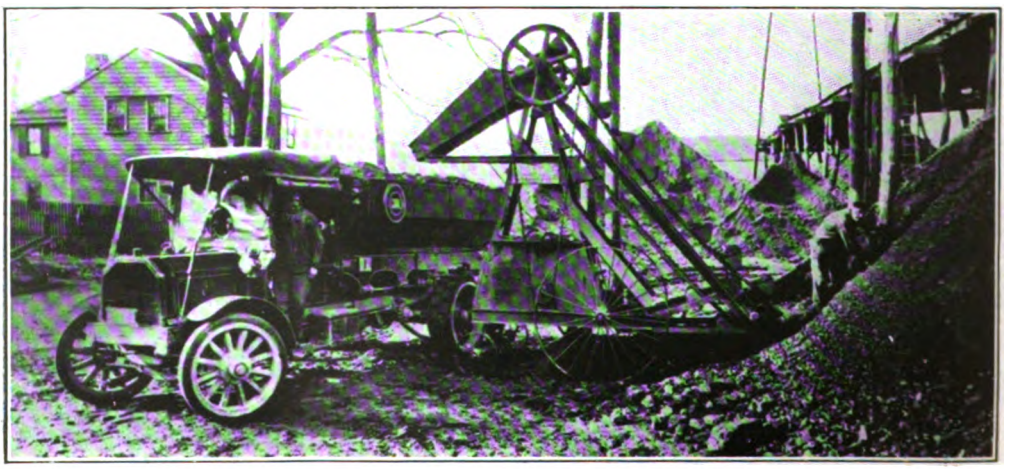
PORTABLE GASOLINE AND ELECTRIC MOTOR DRIVEN TRUCK LOADERS ARE UBIQUITOUS IN THEIR VERSATILITY—IN THE HEART OF THE CITY OR IN THE WILDERNESS THEY ARE EQUALLY EFFICIENT

cesses not alone in the older mechanical industries, but even in the passenger car industry. Improved production methods have resulted in improved workmanship, in the installation of heat-treating plants, in the substitution of machines for men, and in a high standard of mechanical accuracy and workmanship. And producing in ten-fold quantity, the old laws of economics applying to quantity production have enabled truck manufacturers to approach, at least, the economies which have been the conspicuous causes for the decrease in the average price of the passenger motor car from $2,315 in 1907 to $814 in 1916.

Effects Upon Merchandising

More intelligent merchandising of motor trucks has followed as a direct sequence of the formerly common unbusiness-like and extravagant selling policies which led to so many prema-



THE MOTOR TRUCK IS BRINGING ALL MANNER OF EFFICIENCY LOADING APPLIANCES INTO USE

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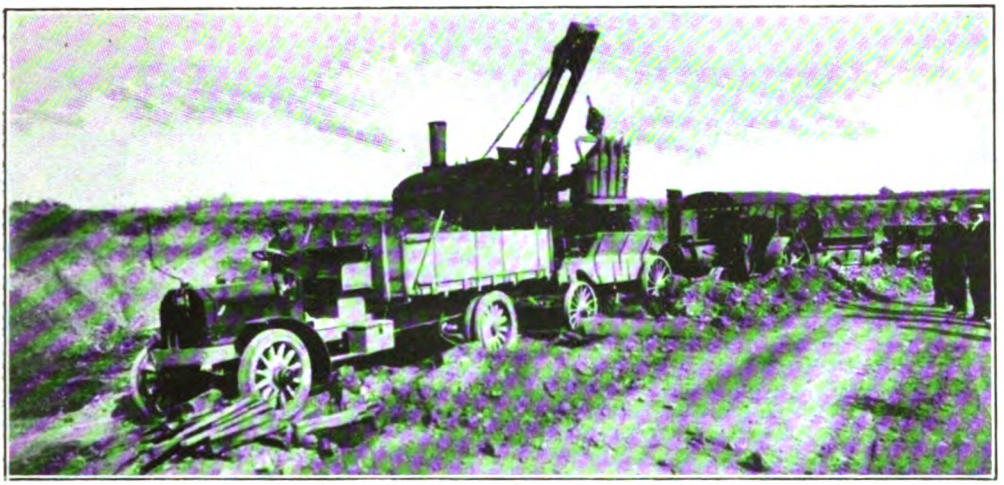

BUILDING AN INTERNAL WATERWAY

The time is rapidly approaching when the motor truck will be regarded as indispensable in big engineering developments

ture failures and retirements from the industry in the three or four years prior to 1914. Supply and demand have been a prominent influence in the passing of wild-cat merchandising methods in the truck business. Prior to August, 1914, there was an over-supply of motor trucks for the existing demand, but since August, 1914, every truck manufacturer producing a more or less dependable machine has found it difficult to keep his supply adequate to the demand. Thus, truck manufacturers should naturally "tighten up" their lax selling policies and refuse foolishly long terms, "guarantees for life," paternalistic interest in the truck so long as a spoke remains in the wheel, acceptance of used trucks in exchange for a new truck at two to three times the actual market value of the used truck, "asking" prices from 20 to 30 per cent higher than "taking" prices, acceptance of horses in barter and exchange for motor trucks, and a num-

AN EXAMPLE OF THE "ONE-MAN TRANSPORTATION" VALUE OF MOTOR TRUCKS

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CARRYING BEEF IN THE ARGENTINE FOR REFRIGERATION PRIOR TO SHIPMENT TO THE UNITED STATES

ber of other merchandising maladies incident to nearly every industry before it passed out of the mushroom stage. Truck manufacturers began to wake up to the fact that there was an actual deficit occasioned both by the needs of the European Powers for enormous numbers of motor trucks as military transports, and by the demand for motor trucks in the home market created from the prodigious publicity received from the Great War. Recognition of the value of the motor truck, which was predicted as at hand six or eight years ago, *has actually only begun to arrive.*

Effects Upon Prices

As the Great War has accelerated the demand for motor trucks in peace-

COLLECTING CITY WASTE BY MOTOR TRUCK

Instead of the old-fashioned horse cart of evil smelling and noisy fame, progressive cities are now using covered motor trucks of the worm-gear-drive type, which make their collections at night without noise and by day without nuisance

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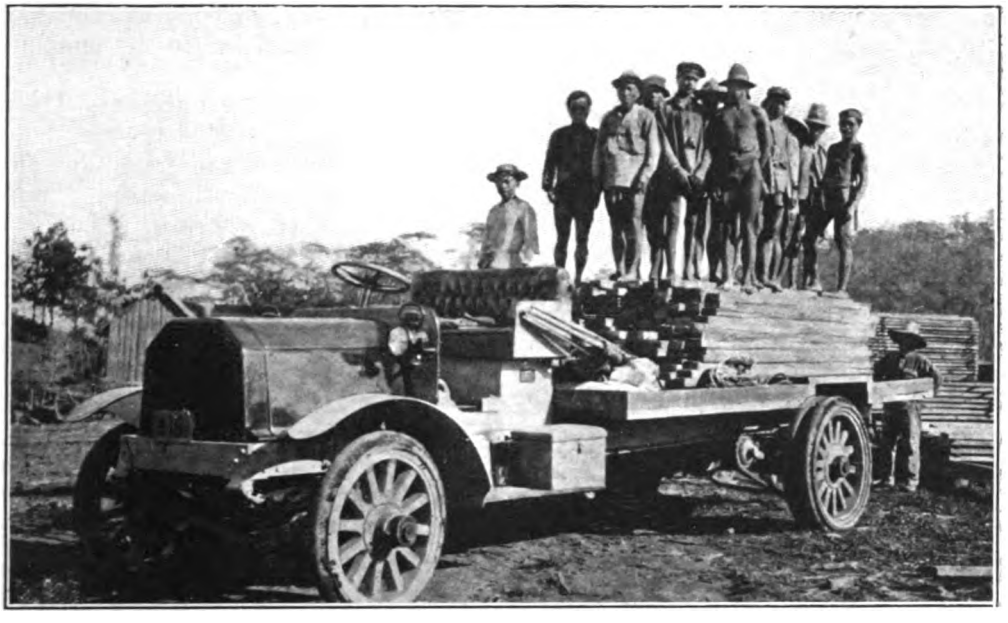
ful pursuits, so likewise it has hastened the growth of mechanical haulage, and has enabled manufacturers to reduce prices as a consequence of tremendously increased production. True, at this writing, a study of comparative prices of first-quality motor trucks will not reveal any noteworthy reductions, *but immediately the war stops, and even before, there must come a conspicuous reduction in present prices.* Manufacturers will make the reduction *both from necessity and from choice.* With physical equipment—plant investments doubled and trebled in some cases, these producers must stimulate the growing wave of popularity in order to continue paying dividends as well as to make initial reductions of from 20 to 30 per cent below current prices. Indeed, many will gradually come to a new scale of prices because of the natural decreasing scale of prices brought on by the increasing utilization of motor transportation, repeating the history of supply and demand as exemplified by the passenger car. The present prices of motor trucks are entirely too high for the buying power of the masses; and until business highway commerce is motorized to four times or more the present extent of passenger highway transportation, the larger benefits of mechanical transportation cannot be realized.

The Great War has gratuitously bestowed upon the motor truck industry an amount of publicity of a permanent value which cannot be measured by any monetary units. We can only gage it by the advertising man's measuring unit, the value of the "white space." By this measuring rule, the author ventures the assertion that $10,000,000 would not have bought the equivalent "white space" in the representative daily public prints, standard periodicals, and industrial magazines. And why? Be-



LUMBERING IN THE PHILIPPINES

Contrary to the impression given by the picture, the advent of the motor truck has been a powerful civilizing agent in our territorial possessions

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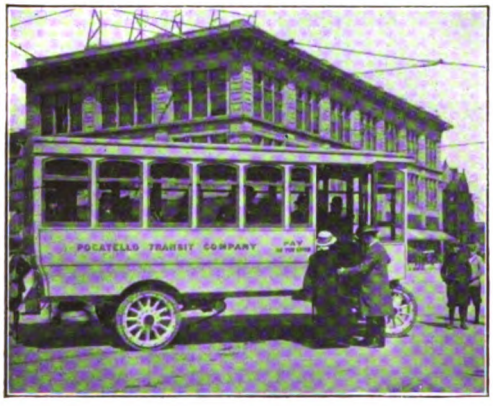


THE JITNEY OF THE FUTURE

The small unit Jitney developed from hard times is rapidly passing. The above shows a 20- to 50-passenger highway coach *de luxe*

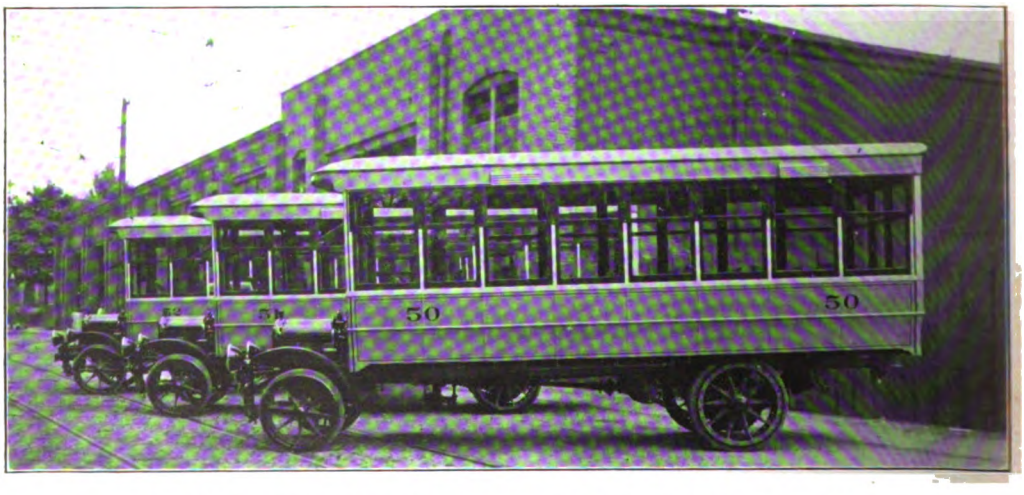
cause the motor truck has written history of its wonderful and, in war, its *dreadful* efficiency, which practically forced its domination of valuable news positions. Day after day, the business man has gazed upon the front pages of his favorite newspaper or illustrated weekly, showing the motor truck in all kinds of strenuous work—bloody and humanitarian work alike on the battle fields of Europe—and sub-consciously these pictures have burned themselves into his brain. The most hardened skeptics have been disillusioned of their beliefs that the motor truck is an experiment, *and when the real history of the part the motor truck has played in the European War is written in permanent records, it can be said that only then did the power wagon have its actual beginning as an efficiency machine.*

Other Effects

To make a reasonably safe prophecy of the permanent results of the War upon the motor truck industry requires an analysis of certain other influences in addition to the ones already discussed.

In addition to the publicity—truly a godsend to any industry—the War has demonstrated the "mechanicalizing" of industry—the use of machines for muscle wherever possible—and the growing utilization of the passenger automobile.

In the "yellow" press, and even in some high-grade publications, we read much piffle that "all the horses in the United States will soon be shipped to Europe for army service, and farmers and merchants will be



FIGHTING THE JITNEY BUS WITH A BETTER AND BIGGER WEAPON

These motor trucks are used by the Cleveland street railway company to pick up traffic in outlying railless territory

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A 1-TON MAIL STAGE MAKING A 3000-FOOT CLIMB IN 12 MILES FROM IDAHO SPRINGS TO ALICE, COLORADO

forced to use tractors and motor trucks." The "forced" part of this statement is very well put, but only in the sense of choosing the motor way or else being *forced* to failure on account of the inefficient and wasteful horse method. Merchants who cannot resist sticking in the old rut can still use horses if they elect instead of motors. Up to this writing, *a half million horses valued at approximately* $125,000,000, *which have been exported from North America since the War began, actually represents but less than one-half of one per cent of the* 26,000,000 *horses and mules in this country,* according to the Government's last census. It is true that if the present rate of 40,000 to 50,000 horses exported per month be kept up for a year or two longer, the effect will be *intensely serious.* Indeed, even now, if all further exportation of horses should cease, the influence

ELECTRIC MOTOR TRUCKS USED BY THE PROGRESSIVE LIGHTING AND POWER COMPANY OF RICHMOND, VIRGINIA

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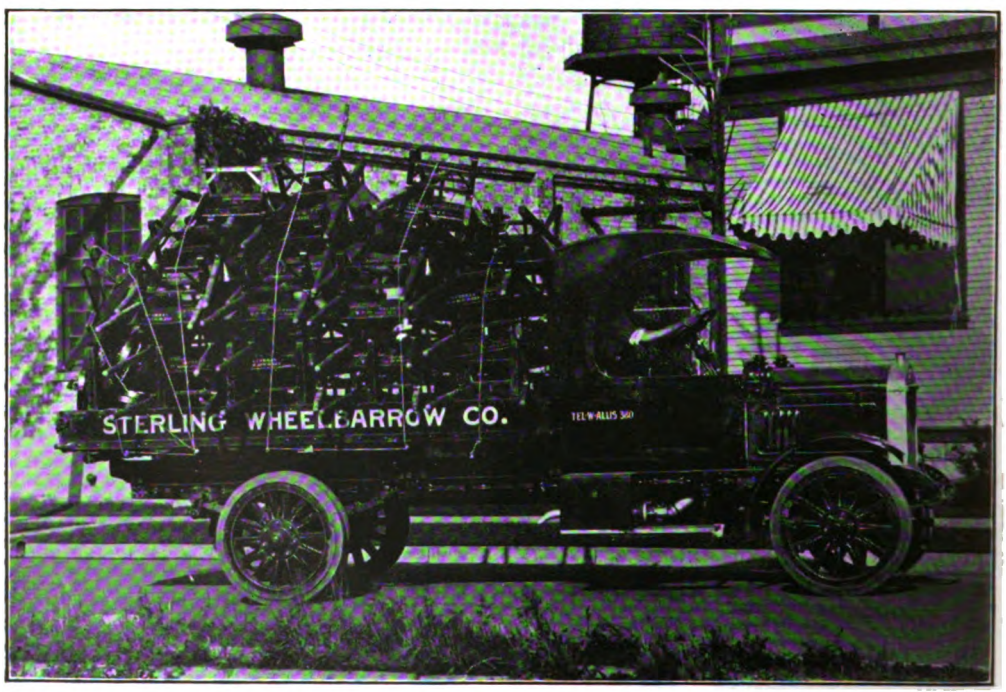
AN UNCOMMON SIGHT TWO YEARS AGO

Today progressive foundries are using heavy duty trucks for interurban hauls, thereby developing customers in zones where delays and added cost in short haul freight service debarred them from getting patronage

of the 500,000 horses already sent abroad will be felt for the next fifteen to twenty years in the horse-breeding industry and markets of the United States. One need make only a casual perusal of the specifications of the English and French armies on the kind and quality of horses to be purchased to understand that the very pick—the cream of the American



THE MANUFACTURER FROM PINS TO PICKELS, WARMING PADS TO WHEELBARROWS, IS FINDING THAT EFFICIENT DELIVERY IS AS BIG AN ASSET IN GETTING MORE TRADE AS A GOOD PRODUCT

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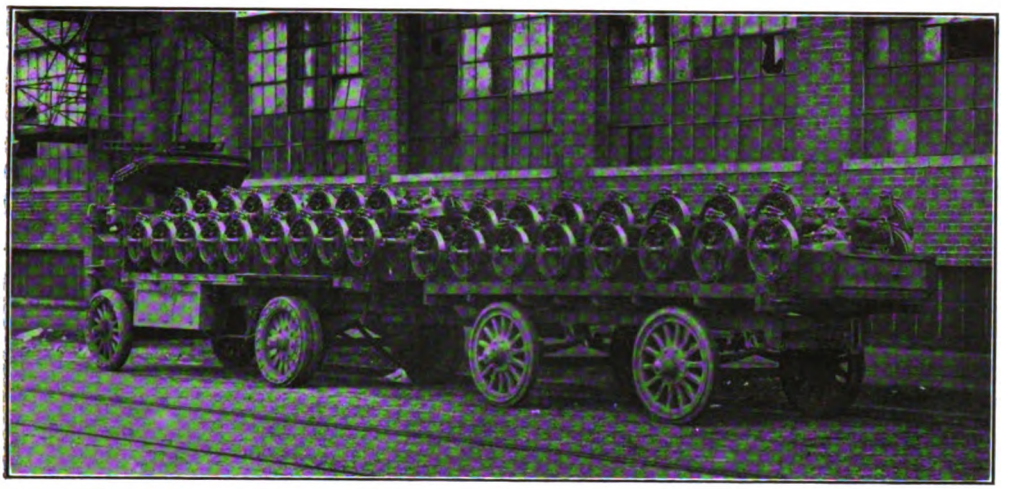

A 3-TON MOTOR TRUCK PULLING AN EQUAL LOAD OF TIMKEN AXLES ON THE TRAILER
Several enterprising manufacturers have made use of the fact that the draw-bar pull of a well designed truck is approximately one-half of its rated capacity in pounds. It is not uncommon now to see a 3- or 5-ton truck towing three times the load it carries on its own body

horse-breeding stock—has already been *pickled in quick lime or devoured as carrion on the battle fields of Europe.* It stirs the emotions of even the most intense enthusiast on motor transportation to contemplate the brutal, inhuman sacrifice of America's finest specimens of the equine race to appease the blood-thirst of Mars. Undoubtedly fifty per cent or more of

THREE YEARS AGO MOTOR TRUCKS IN POWER PLANT CONSTRUCTION WERE RARELY FOUND. TODAY THEIR USE IS COMMON

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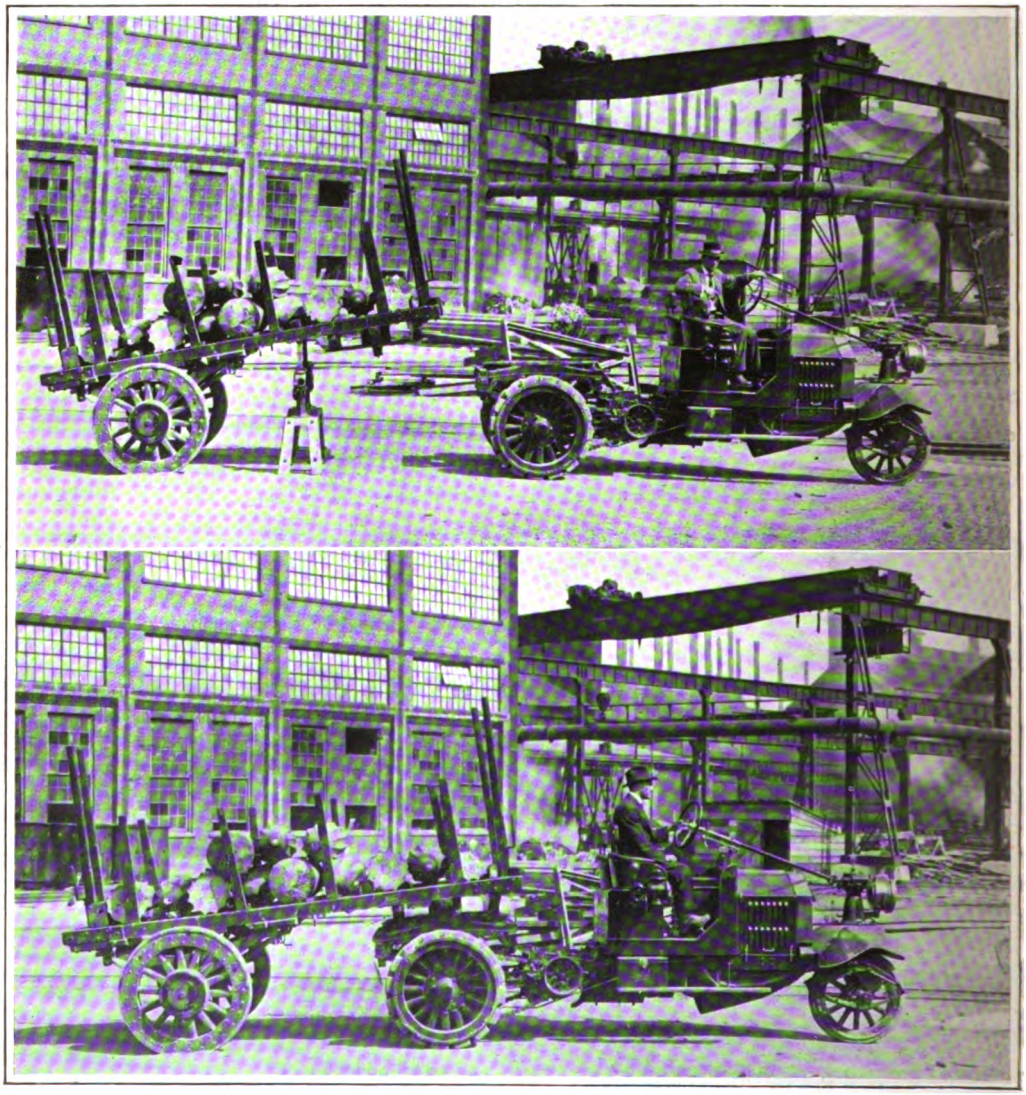
these fine animals have been mares, and as it requires from four to six years to replace stock even of the poorest kind, *we cannot for the next half century restore the standard to which our horses had attained at the beginning of the Great War.* We can get no more fine specimens from Europe for the next quarter of a century or more, for Europe has long since destroyed the noblest propagators of the equine family; and the Mendelian laws of heredity are inexorable. We cannot perpetuate a good quality stock



COUPLING A SEMI-TRAILER TO THE TOWING UNIT

Traction trucking takes the form of either the straight tractor, or semi-trailer combination, or the separate trailer. Each has its advantages. The semi-trailer is more compact, turns in a shorter radius, and tractive resistance on rear tires of the towing unit is less severe. The separate trailer is more flexible in that any number of trailers up to the draw-bar pull of the "locomotive" may be employed, each trailer is independent as to kind and amount of load, and, finally, the "locomotive" without trailers, can handle its own load, whereas the only function of the towing unit of the semi-trailer is its draw-bar pull. On severe roads the semi-trailer type is the more practicable

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of horses from the altogether too scarce specimens of right quality; only by long patience can we rehabilitate the horse family in America.

In the meantime, the demands of commerce cannot wait upon the restoration of the stock. Already the one- and two-unit horse user is debarred upon the death of his present animal, in many cases, from continuing horse delivery. In many cities, a first-quality draft horse that sold at $250 eighteen months ago now commands $350 to $400, with prices constantly advancing. The brewer or wholesale merchant who would match a beautiful span of Percherons that cost him two years ago $600 may now have to pay $850 to $1,100—and the end is not in sight. If not from choice, *from necessity,* highway commerce must be motorized. The stoppage of the Great War will awaken American truck manufacturers, who have not by then realized that the present big discrepancy between prices of passenger and commercial motor cars cannot continue (if he would keep his big investment paying), to the fact that he must bring down prices to a scale which will not exclude, as present prices do, a vast number of anxious-to-motorize business firms from carrying out their wishes. Thus, by forcing undreamed expansion and growth in the truck industry, the Great War will compel the remaining manufacturers to give the public a better motor truck—a constantly improving truck at a constantly lowering price. *And the great business public will show its appreciation by buying such amounts as will enable quantity production economies.*

How is the American truck industry preparing for this long delayed but well merited era of activity and prosperity?

Of the seventy-five commercial car manufacturers in the United States, it can be said that at least fifty have already doubled or trebled their productive capacity or are preparing to do so. Of the eight largest producers, practically all of whom, prior to the Great War, were conspicuous principally as pasenger car producers, the growth of their business which was formerly the tail, has placed them in the ridiculous position of the tail wagging the dog; the volume of their truck business now greatly exceeding their passenger car business. In not less than three instances the Great War was the salvation of some of these larger manufacturers from a bankruptcy brought on by the sudden and unexpected decline of the market for the high-priced passenger cars, formerly the life blood of their business. But even among the medium and small manufacturers plants have been, or are being, doubled and trebled in capacity, and the war is conspicuous in having brought to the fore-front a number of small, and formerly inactive motor truck manufacturers. If the anticipated demand comes, as is reasonable to suppose, the majority of manufacturers will be prepared for it. Our condition is very different from that of English and Continental plants, where *man labor* instead of *machine labor* is largely used, and production in consequence is smaller. The chief worry of most builders is the materials market. The tremendous demand for metals for making munitions of war, and the plethora of prosperity in the passenger vehicle field has caused a scarcity of supplies, but at this writing the material markets are easing up, and by Spring, which is the most active buying season for motor trucks, the materials markets should be nearly normal.

The foreign demand will not cease suddenly. Many orders from Europe

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have been placed for periods of from three to five years ahead, and it is interesting to note that a number of these orders are not for trucks for military but for civilian usage. The commandeering of the truck factories of England and France and the wholesale confiscation of domestic trucks in those countries has opened up a permanent market in Great Britain, France, and Russia. *European manufacturers are genuinely worried.* Indeed, English manufacturers having their plants under "control" by the Government, have insisted upon and will likely obtain a reprisal against the American invader by forcing the proposed 33 1-3 per cent ad valorem tax upon imported trucks. If this English tariff law and a probable import tariff in France on motor trucks is enforced, it will act as a stimulant to the reduction of American price lists, because English and French trucks of first-quality are lower in price than American trucks of equivalent capacity; and the present abnormal freight rates plus the excessive tariff duties will make it impossible for the American manufacturer to compete against the English and French maker when the war ceases. Probably all French and English truck factories will be intact at the end of the war, and although the depletion of the supply of the best mechanics will be serious, at the same time the French and English builders, to rehabilitate themselves, will be content with a smaller profit per unit product than they were before the war, and, aided by tariff duties, England, and France may seek to exclude American trucks.

The vast number of military trucks left at the end of the war will, to a certain extent, act as a barrier to the American manufacturer and keep him from entering European markets, but the effect of these hosts of army trucks should not be as serious as has been predicted.

Although Chancellor McKenna, under the protest of the large number of British agents for American trucks, has exempted commercial vehicles from the payment of the 33 1-3 per cent ad valorem tax, the probabilities are that the pressure of the English truck manufacturers will force the enactment of this tariff.

The French Government has taken steps to exclude foreign-made motor trucks by imposing a duty of 45 per cent ad valorem on trucks and parts not purchased by the Government itself. A recent cable states: "The new French tariff is taken to indicate that shortly French builders will be able to re-enter the home market, and while there has been practically no attempt on the part of the American manufacturers to compete with French makers, it is a bulwark against the feared competition which the English have experienced."

It can, therefore, be safely said that restrictive tariffs, and not the difficulty of absorption through commercial channels of the trucks left in the hands of the Governments at the end of the war, will prevent the anticipated large market for motor trucks in Europe. Necessity and not any particular hostility towards American made trucks will force tariff reprisals, despite the fact, as a recent cable from London states, that "American made trucks have been one of the biggest factors in saving the Allies from utter defeat. . . . At home, the American trucks placed on sale have been little short of a godsend to English merchants and tradesmen who have had their vehicles taken away from them at the beginning of hostilities and who were unable to buy other British chasses to replace them, owing to the tying up of outputs by the War Offices."

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Although some makes of American trucks have, when intelligently handled, made an equal and even better showing than British and French trucks, it is but natural that these Governments must assist their manufacturers, whom they helped to disorganize, into regaining their foothold by placing prohibitive import tariffs on American trucks. Therefore, *the American truck industry must depend upon home markets and such of South America's markets as it has the enterprise and foresight to begin to develop before the English and French manufacturers are prepared to regain their markets in South America.*

THE SOUTH AMERICAN MARKET

Many gallons of good ink and hundreds of square feet of "white space" have been filled with discussions of the marketing possibilities for motor trucks in Latin-American countries. That there is already a definite and potential market for motor trucks in these countries cannot be gainsaid, but the present and future market for the next decade has been greatly exaggerated. It must not be forgotten that a motor truck is not a transportation tool suitable for primitive, undeveloped highways. We know that certain large cities of South America have streets with pavements as modern as in New York or Chicago, but in other highly populated cities pavements are either extremely crude or do not exist at all. And in the interior, even a few miles from the larger cities, the only vehicle that can "mote" is a high-wheeled ox-cart. True, the tractor-truck might cope with these aboriginal conditions, but the tractor-truck cannot be handled by native labor; and it must not be forgotten that most portions of South America are too uninviting for the relatively skilled, intelligent labor required to handle satisfactorily any type of motor truck under the adverse conditions prevailing in these countries. In the copper mining zone of Ecuador and Peru, in the great pampas region of the Argentines, in localized zones in Brazil and Uruguay, a fairly good market for motor trucks exists, particularly for capacities up to two tons. Traction difficulties make it almost impossible outside of the larger cities to use machines of larger tonnage.

OTHER MARKETS

Summarizing, it can be conservatively stated that of the countries of Europe only Russia really offers any great permanent market following the Great War for American motor trucks. If the British and French tariff laws should be waived, the situation would be different, because with prices as low as the best grades of trucks made in these countries, American manufacturers can force a market from which they can never be dislodged; but they certainly cannot force these markets against prohibitive tariffs.

Germany has never bought any American motor trucks and most certainly will not buy any after the Great War, even if a driver and a year's operating expenses were thrown in gratis with each truck.

South America favors the European product, but can be educated to the advantages of the American machines if European introductory methods are at all times followed.

Australia, India, and the Orient are small users of motor trucks. Australia is by far the most inviting market for American manufacturers among the English colonial countries. While largely pro-British in sentiment, the Australians have been influenced largely by the considerable number of American business men in that country, and they are not hostile to American-made trucks.

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China and Japan can secure manpower so much cheaper than machine power, and the percentage of business firms large enough to have means for buying, or to need motor trucks, is relatively too small to expect any notable market for trucks in these countries for many years.

In a word, therefore, *the wise American manufacturer is preparing for the cultivation of home markets.* With a potential need of 3,000,000 to 4,000,000 motor trucks in this country within the next decade, truck manufacturers have enough business ahead of them, if they prosecute their opportunity to the fullest extent, not to suffer any need for foreign business; although the most successful will be those who neglect no opportunity to cultivate foreign trade also.

The discovery by many business firms that the original sizes of trucks installed in their delivery service were too large for most efficient application has been followed by a replacement of thousands of over-capacity trucks with machines of more efficient load capacity, in most cases with trucks of 25 to 50 per cent less tonnage than were formerly considered suitable. Five- and seven-ton truck units are becoming common; the imaginary difficulties against their usage are being eliminated; and concrete, brick, and macadam highways are making practicable long-distance suburban and interurban freight haulage.

In conclusion, the pictorial features of this article show some of the newest applications of motor trucks in trades and industries in which two years ago they were practically unknown. The Henry Ford of the motor truck industry remains to be yet developed; and it suffices to say that no other mechanical industry in America offers such a genius such a large reward for making possible the ubiquity of his product to the extent which even Mr. Ford has made of his passenger vehicle. And the genius who will bring his product within the buying power of the millions who want to motorize their business will have achieved even a greater benefaction—a greater philanthropy upon the human race—than has Mr. Ford, because he will be one of the chief agencies in saving countless millions to commerce.

The motor truck industry of the United States, while much smaller in investment standing and in number of employees than the passenger car industry, or a number of the older mechanical industries, nevertheless carries at this writing approximately an investment of $250,000,000 and gives employment to 85,000 men. As compared with the investment in 1911 of $50,000,000 and 15,000 men, the increase has been five fold monetarily and about six fold in labor employed. Surely in an industry whose commercial history really only began five years ago, it is safe to predict that the impetus given it by the Great War plus the momentum of natural causes will mean that within the next five years the investment of 1915 will have been quadrupled or quintupled. Inevitably from a despised side issue, the motor truck will outstrip the passenger car industry before the next decade has passed and will become the most prominent mechanical industry of the United States.

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PRODUCTION AND SALES

By Henry L. Gantt

Mr. Gantt evolves some interesting curves showing the relation between prices and profits. He refutes the theory that high selling prices are necessary to large profits, citing the Ford car as an example. In conclusion he calls attention to a serious defect in our modern cost systems, and maintains that the output of a factory should not bear the *total* expense of the factory, but *only that portion* of the expense actually required to produce it.—THE EDITORS.

IN the paper presented last month not only was the importance of leadership in industrial affairs dwelt upon, but also the idea was presented of how industrial leaders may be developed and trained for the direction of our industries in the production of wealth and the increase in happiness of our people. This leads naturally to the broad subject of production.

A nation's wealth depends ultimately on its powers of production. Buying and selling articles within a nation transfers such articles from one ownership to another, but such changes in ownership do not increase the amount of wealth, although they may put it in more available form. Iron ore in the earth is worth very little; the same ore *mined* and *transported* to the blast furnace is much more valuable; changed into pig iron it becomes more valuable still; changing the iron into steel still further increases its value; finally the hairspring for a watch made from this steel is worth more per ounce than the ore in the earth was per ton.

The progressive increase of value is due to human labor. The cost of the various transitions through which the iron ore has passed before it becomes a watch spring depends upon the intelligence and efficiency with which that human labor has been applied. The object of all of our industrial efforts is to transform comparatively cheap raw materials into valuable products. The central idea of all industry, therefore, is production, and all our efforts should be bent on producing as efficiently as possible.

This is a very different condition from merchandizing, in which the buyer cares but little who produced the article or indeed for the cost of production provided he can sell it at an advanced price. He has his function as a distributor, which is very different from that of a producer; the two have had but little in common. Perhaps it is the fact that the merchant has usually not needed to take into account the interests of the producer that has made him so slow in recognizing the important part the producer plays in modern industrialism.

It has always been the case that the distributor received a larger reward financially for his services than the producer, but the time has come when the producer, as represented by the industrial workman, is demanding a larger share in the profits of his labor. Much advance has been made within the last few years in recognizing the justice of such a claim and rewarding it by a corresponding compensation,

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but the problem will not reach its proper solution until it has been recognized that the distributor is getting a larger share than his services entitle him to. It has been contended by some successful men that the salesman was really the producer. The function of the business being to produce money, the salesman who brought in the money was therefore the real producer. Such a view of an industrial organization is apt to produce a very unbalanced distribution of reward.

The problems of producing and selling are in reality very closely linked. If we produce an article for which there is a large demand and sell it for a price which most people can afford to pay, the cost of selling that article in large quantities will be extremely small. The Ford automobile is perhaps the most prominent example of this in the country. Mr. Arnold, in the pages of THE ENGINEERING MAGAZINE, has presented very full descriptions of the manufacturing methods of the Ford shops. These methods are all very interesting and the shops are undoubtedly being well run, but probably no better run than would be the case in other factories having a similar product and output. It probably would not have been economical to develop all the methods which they have in operation without a very large output; their organization, therefore, and their shop methods are largely results of a large output, and the question which presents itself to us is—How did it become possible for them to sell such a large product? The answer is—*They sold something that people wanted at a price that many people could afford to pay.* Their unprecedented profits have proved the wisdom of this course. Just as in my former paper I tried to refute the theory that low wages are necessary to low costs, *this example seems to refute the theory held by so many business men, that a high selling price is necessary to large profits.* The object of any business, of course, is to make as great a profit as possible, but as the total profit in the business is the profit on the individual article multiplied by the number of articles sold, the real problem of the salesman is to find at what selling price this rectangle is largest.

To make this clear I have used Charts I and II, which do not represent specific cases, but are simply intended for illustrations.

We all recognize the fact that as the selling price becomes higher, more effort is in general needed to sell the goods, and consequently the cost of selling is increased. If in Chart I we represent the distance from the line *A B* to the line *C D* as the cost of an article, and the distance from the line *A B* to the line *C E* as various selling prices, we may draw from the line *C E* downward short lines *F G, H K, L M, N O, P Q* representing the cost of selling at the various prices; then the distances from the points *G, K, M, O* to the line *C D* will be the profits realized on the various sales.

If you draw a line *R S* perpendicular to *C D*, and lay off in the direction of *S D* the number of articles sold at any given price, and in the direction of *S R* the profit on a sale, the area of the rectangle constructed on such lines will represent the total profit at that selling price. You will note that at the selling price *P* there is no rectangle; at the selling price *N* the number of pieces sold is represented by *S N'*, and the total profit as represented by the rectangle is *S O'*; at the selling price *L* the number of pieces sold is *S L'*. The larger number of items sold has reduced the cost of selling and increased the profit per unit in spite of the lower selling price. A much larger rectangle *S M'* of total

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profits is the result. At the selling price H the number of units sold is much greater still, though the individual profit is somewhat less, and we have the area of the rectangle $S\ K'$ representing the profit. At the selling price F the number of sales is still larger and the area $S\ G'$ represents the total profit.

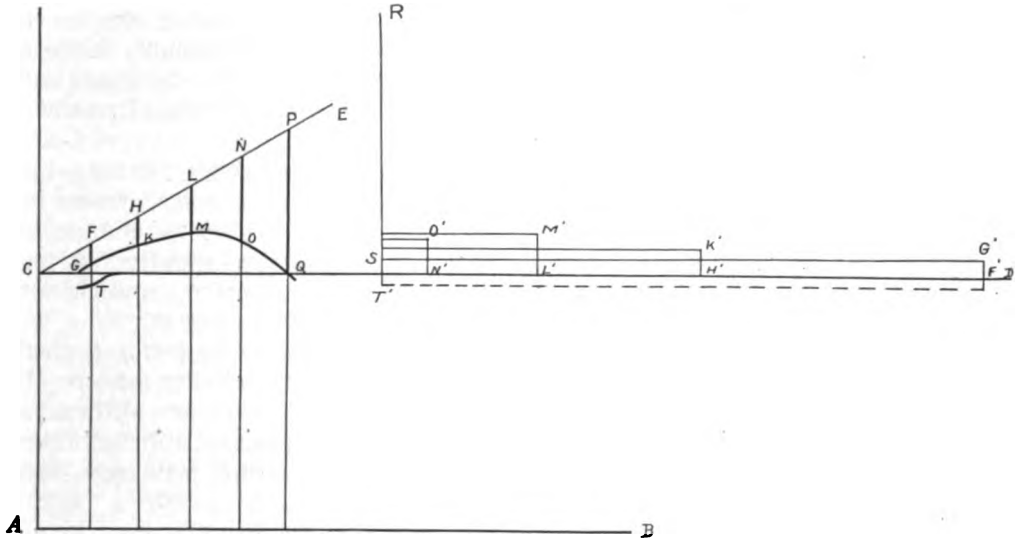

CHART I. EFFECT OF SELLING PRICE ON PROFITS

When, however, the sales become sufficiently large, as in the case of the Ford Company, to enable us to put in special machinery to do our manufacturing, we can reduce the cost. Our profit per unit may now be repsented by the line $G\ T$, and our total profit by the rectangle $T'\ G'$. This is the kind of rectangle that best represents the business of the Ford Company. Such a rectangle can be developed in any business where there is a large demand, provided the selling price is low enough.

I once heard a salesman make the rather contemptuous statement, that anybody could sell a good article at a low price, but it took a real salesman to sell a poor article at a high price. Fortunately, there are not to-day as many salesmen of this type as there were a few years ago; although the tribe is not extinct, however, and I fear far from it, for I met three of the old type together on a train only a few weeks ago. Moreover, *people are beginning to realize that there is no great ultimate profit in trying to sell a person something out of which he cannot get the value he paid for it.*

Chart I should be supplemented by Chart II, in which we represent by the distance $A\ B$ the normal selling price of an article, and by the distance $B\ C$ the average number of articles sold at that price. If the selling price is decreased, say, to $A\ D$, the consumption of the article will usually increase; and if the price is increased from B to E, the number of articles sold will normally decrease. We may then draw a line through the point C in such a manner that the distance from that line to the line $A\ B$ will represent the number of articles sold at the various selling prices. The shape of this line, or curve, will not only vary with almost every article and every selling policy, but will probably be affected by a number of other conditions. Nevertheless, it should be

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possible to get some general idea of its normal shape, and the effect produced by changing conditions. Such a curve in connection with a chart of the type of I for the same article should give us valuable data on which to base a policy of production and sales.

While it would be very difficult to predict the exact shape of such a curve in any individual case, the general tendency of these curves for classes of materials may be clearly indicated.

As a rough classification, all articles that we buy and sell may be put into one of the following groups:

Necessities,
Luxuries,
Conveniences,

and the general shape of the curve for a group indicated.

In the case of necessities, a slight increase or decrease in selling price would probably not affect the amount sold very seriously, but as the price became so high as to pinch, the amount sold would begin to fall off faster. In the same manner a decrease in price would probably not largely increase the consumption of a necessity until the price was quite markedly reduced, and people began to waste it.

With regard to luxuries, change in selling price would probably have a more marked effect as to increase and decrease than in the case of necessities.

In the case of conveniences, the changes in the number used would be very markedly affected by change in price, higher prices rapidly cutting down the consumption, and lower prices rapidly increasing it.

The automobile industry is a good example of this condition, as are all labor-saving appliances. When a labor-saving appliance approximates in price the amount it will save, few

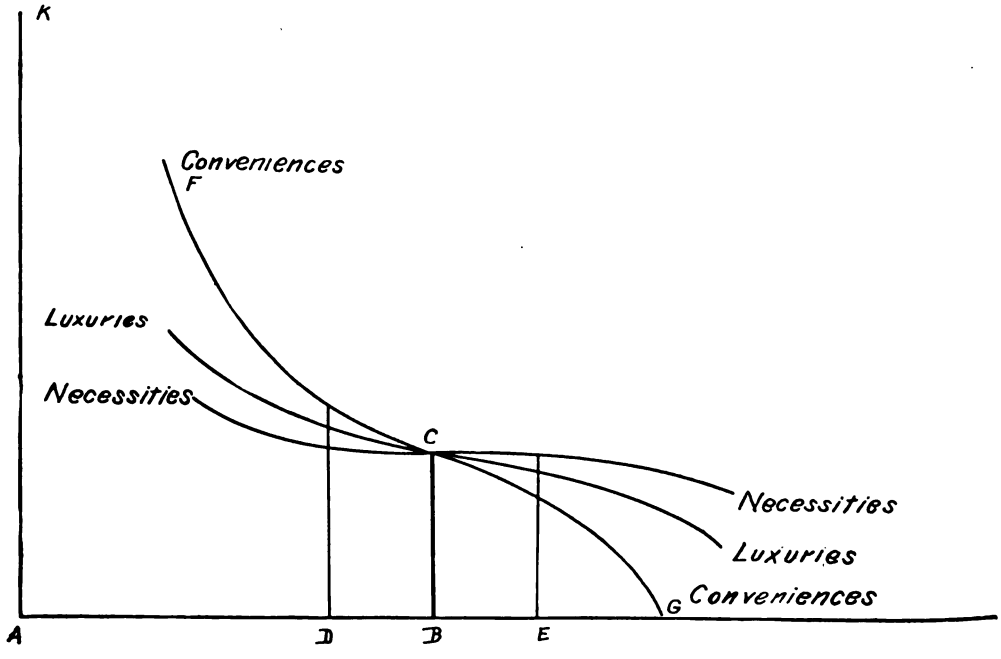

CHART II. EFFECT OF SELLING PRICE ON CONSUMPTION

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people will buy it; while if the cost of it is only a small fraction of what it will save, there is a tremendous market for it. Consequently, the line *F G*, representing the sale of labor-saving appliances, rapidly approaches the line *A B* with increase of price, and has a tendency to become nearly parallel to the line *A K* as the price is reduced. It is unquestionably the real problem of the salesman then to find the shape of this curve for the particular product which he has to sell, and having found such a curve, the fixing of the selling price can be done in such a manner as to afford the maximum of total profit.

This problem from its broad standpoint has had but little attention in the past, for the theory that it was necessary to have a high selling price to get a large total profit has been almost universal.

If the Ford automobile had not done anything but refute this commonly accepted theory, Mr. Ford would have done a great service to the country. Whether his methods of profit sharing are ultimately going to be successful or not is an open question, for Mr. Ford's great profits have been largely due to the fact that he, like Mr. Carnegie, was the first to recognize an important principle which was being ignored by his competitors.

Mr. Carnegie realized that if he did not run his plants at all he would lose a large sum of money each year, and that he would be far better off to lose that money running his plants than to lose it if his plants were idle. His competitors preferred to close down their plants, with the result that they not only lost the money due to their idleness, but were not ready to take advantage of new business when it came. Mr. Carnegie, on the other hand, was ready at any moment to take advantage of any business offered, and the start he thus gained made him practically the master of the steel industry in this country.

Mr. Carnegie's results would seem to throw some doubt on the soundness from an economic standpoint of the policy of holding up selling prices in times of depression, and make some of us wonder if it is not better in times of depression to stimulate industry by selling articles at the price they will bring, and thus shorten the period of depression. Is it not possible that the money lost during depression would be regained more promptly by this method than by holding up prices to such a point that nobody could afford to buy and thus prolonging the period of depression?

It is an undoubted fact that if a means could be found for continuing production during a time of depression, the continued increase in wealth thus produced would be beneficial to the country at large and, hence, indirectly to all the people. Even though those directing or controlling the industry would not acquire their profits as directly as before, they would come in for their share on the wave of the more promptly returning period of prosperity.

This and other questions of a similar nature are the ones which the industrial leaders of the near future will have to face, for it looks as if many of our industrial policies will shortly undergo radical changes.

One of the most serious defects in our industrial system, and one which has been responsible for more poor business policies than any other, is that due to the lack of a satisfactory cost system.

It is a rare thing to find two concerns that have even approximately the same cost system, except, by chance, their systems were both installed by the same accountant. In fact, there are today almost as many

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cost systems and methods of distributing the "burden" as there are cost accountants, each of whom seems to have his own idea as to the function of a cost system, and has developed his system in accordance with that idea. There does not seem to be any universally accepted principle on which such a system should be based. The one most commonly accepted is that the product of a factory must bear the total expense of owning and operating that factory, whether it was all utilized for producing that output or not. Some cost accountants even insist that the output of any month should bear the total expense for that month. In the case of a plant running at its full capacity and putting out a uniform product month after month, such a system would give reliable results. If, however, the output varied seriously, the results of this method of figuring would be very misleading, for the fixed expenses of the factory would, in a lean month, be distributed over a small product and make the product show a much larger cost than would be the case when the factory was running full.

Inasmuch as production and selling policies must be based on costs, it is easily seen that under such a system both financier and salesman must necessarily be confused as to the policy to adopt.

It is not surprising then, that many managers have often gone ahead successfully regardless of the figures of their cost accountants, while others who have been guided by these figures have not been successful. It also explains the fact that some concerns that have not had cost figures, but whose managers trusted to their common sense have been more successful than some with elaborate cost systems. From this we may conclude that unless figures convey the correct idea they may be worse than useless. This situation has been pretty generally recognized during the past few years and numerous attempts have been made to discover where the error lies.

The result of these investigations is the conclusion that the fundamental principle on which most cost systems of the past have been based is wrong. The newer theory, and the one which is rapidly finding acceptance, maintains that *the output of a factory should not bear the total expense of the factory, but only that portion of the expense needed to produce it.* As an illustration:

If a factory is turning out only half the output of which it is capable, that output should not bear the total rent, insurance, and taxes of the whole plant but only half of it. This theory, which, as just said, is rapidly gaining acceptance, is most far-reaching in its effects. First among them is that the expense of maintaining a plant, or a portion of a plant, in idleness must be regarded as a business expense, and chargeable to profit and loss—not to the cost of the articles manufactured, the cost of which remains constant as long as the method of manufacture, rate of wages, and price of materials do not change. Under this theory there may be a good profit on what we make, but the expense of maintaining a plant, or a portion of a plant, in idleness may be so great as to absorb all the profit and cause a loss to the business. The older system of cost keeping did not make this so clear, or the practice of buying out competitors would never have become as common as it has been; nor would manufacturers have been so ready to extend their plants until they had exhausted every possible means of getting an increased output from the plants they have. The man who can get a large product

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out of a small plant is certainly in a better position to compete than he who requires a larger plant for the same output.

This fact has been so often stated and so clearly demonstrated that it is hard to understand why it is so continuously ignored. Yet financiers, who as a rule determine policies, do not seem to have grasped the idea, and are in general much more willing to spend large sums of money on plant and equipment than smaller sums in putting what they have in condition to obtain a larger product.

The reason for this is that the cost accountant of the past has invariably inventoried the new plant at cost, while he has not been able to place any inventory value on a system of management.

Under our newer ideas of cost keeping the new plant, unless it is actually needed to perform the service for which it was intended, would not go on the inventory at cost but at what it could be sold for, while the expense of maintaining it in idleness would be a charge to profit and loss.

On the other hand, a system of management that enables us to double the output of a plant is of far greater value than a duplicate plant, for the double output from one plant will cost far less than if it were made in two duplicate plants. A cost system to fulfill the needs of competitive manufacture must then show not only what we are spending to obtain our product, but also *what expense we are under day by day for that portion of the plant and equipment which is idle.*

The amount of expense that most concerns are under daily on account of idle plant and equipment is so great as to be absolutely unbelievable. Such expense is truly *non-productive*, and the great need of our industries today is a system that will continually bring this *non-productive* expense, or loss, to the attention of the executive. Such a system has been devised and is in operation, with the result that the executives of those plants where it is in use are learning most illuminating things about their expenses.

This system has been in operation in this country for several years in plants of Swiss origin, which are said to be very successful.

Recently I have heard that it is also in use in Russia.

Inasmuch as both Switzerland and Russia have derived much of their industrial inspiration from Germany, the idea at once suggests itself that this principle may be in quite extensive use in Germany. Such a theory combined with their vast store of technical knowledge would go a long way to explain the success of the German industries, which their lower wage rate entirely fails to account for.

Executives have always realized that idle machinery was expensive, but, in the ordinary system of cost accounting, this expense has been spread on the cost of the product, and has thereby been at least partly obscured. When, however, it is presented day by day in a separate statement from which the expense of each idle machine may be picked out the subject takes another form.

The first question then asked is: Is there any work we can get for these machines that will enable us to make a profit? In case this is answered affirmatively, the problem of getting it is up to the salesmen. In case it is answered in the negative, the next question is: Had we not better sell these machines and replace them with others that we can use?

This second question can usually be answered only after some investigation and frequently only after considerable time. While it is being answered, another question arises: Can-

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not we do some work on these machines which will at least partially relieve us of the expense of maintaining them in idleness? This may be answered by directing the salesmen to look for work, which, if obtained, will result in less loss than would be produced by keeping the machines in idleness.

These are the problems of production and salesmanship which a proper cost system is forcing upon us, and they promise to have much influence in the near future.

It has already been said that people who have adopted the newer cost system are making the paths of their less progressive competitors hard. Certainly that nation which, as a whole, conforms to the newer ideas will be in a much better position than a more conservative competing nation.

There is another step in cost keeping, however, that has not yet been taken. In fact it is so difficult that, as far as I have been able to observe, nobody has done anything about it.

Mr. Carnegie is credited with the statement that if he had to lose his plants or his organization, he would much prefer to lose his plants, for they could be replaced much more quickly than his organization.

Mr. Carnegie evidently considered his organization of more value than his plants, and measured their relative value by the readiness with which they could be replaced.

This is all very well for a man like Mr. Carnegie, but we want a system which will measure the value of systems of management in general, and enable us to put them in our inventory. A going plant operated under an efficient system of management is very different from a similar plant without a good managerial organization.

Our real problem is that of devising a cost system which will reduce these differences to figures. Inasmuch as these differences are fundamentally due to differences in the controlling spirit, the figures obtained will be a financial measure of the value of *leadership*.

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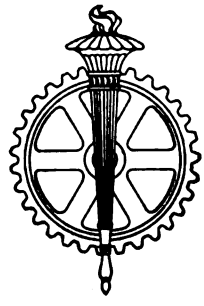

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POST-BELLUM MINERAL PRODUCTION

By Dr. Arthur Selwyn-Brown

Mines throughout the country are being worked with feverish activity in the effort to supply the increased need for metals. Their operators will welcome the assurance given by Dr. Brown that cessation of the war will not bring a sudden slump in prices and market, but that the demand for rehabilitation purposes will be steady for a long period.—THE EDITORS.

THE present war in Europe is destined to result in economic, as well as political, changes of the greatest magnitude. Never before have the markets and commerce of the world been so greatly disorganized, and never before has there been so great a destruction of metals and so pronounced an interference with the metal mining and smelting industries of the world.

The prices of metals, like those of other commodities, are dependent upon the demands for them and the means for satisfying those demands. Mining facilities and costs, taxes, transportation charges, marketing cost, etc., all influence the production of the principal metals. When anything interferes with the regular commercial movements of the ores from the mines to the consumers of the reduced metals, their prices will be modified to a greater or lesser degree. When the war began, the world's trade and financial arrangements were severely dislocated. This led to the closing of a great number of mines and smelting works. It also resulted in closing the markets for many refractory zinc, lead, and copper ores; and this loss of markets led to a reduction in mining operations, and, consequently, the temporary reduction in metal production. Germany, for instance, purchased all the refractory zinc-lead ores of the Broken Hill Mines in Australia and those mined on several of the Tasmanian fields. The war led to the closing of these mines for many months until other markets could be established for some of their output. These interferences with mining operations led to extraordinary expenditures on the part of the mining companies involved, and these expenditures, by taxing the companies' working capital, will tend to restrict subsequent mining.

The war has also seriously restricted maritime transportation, and has increased freights very appreciably. In addition, it has had the effect of changing the reduction centers for many metals. For example, the closing of German ports and the British embargo on the exportation of ores from the British dominions caused Australian miners to find new markets for lead, zinc, copper, nickel, antimony, and other ores which they produce and export in large quantities. They decided, upon erecting large electrolytic copper refineries in Australia, to refine all the copper ores previously shipped to Germany, and have arranged for the erection of extensive smelting works in England to reduce their lead, zinc, and antimony ores. These works will be well equipped and permanent. That means that England will permanently retain these important smelting industries that formerly benefited Germany.

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These new works, however, will not only deal with the Australian ores, but will be able to handle ores from other countries. Many industrial and commercial changes will result from this shifting of smelting centers. One result will be that the British Empire will be able to smelt and reduce within the Empire most of the metals it requires. Subsidiary industries consuming the metals will be benefited by lower costs due to cheaper marketing and freight services. British mine owners will be able, as a result of the successful working of the plants, to secure more easily and expeditiously the additional capital they may require from time to time for new mining developments. On the other hand, any depression in British trade conditions will adversely affect metal mining conditions within the empire, and difficulties may arise in finding suitable markets for some of the by-products of the smelters.

Metal production throughout the world exhibited a strong tendency to a rapid increase before the war started in August, 1914. Statistics relating to the world's production of the useful metals show that since about 1905 there has been a steadily increasing demand for metals. The increases have been most marked in the demands for copper, zinc, and lead. The world's copper production has been doubled in the past twelve years, while the lead output increased nearly twenty-five per cent, and that of zinc has almost doubled since 1898.

It is proposed in this article to review briefly the production of the commoner metals and survey the economic aspects of the mining industries after the war.

Copper Production

The great growth of the electrical industries, the extension of the uses of copper, and the general increase in international commerce in recent years have all contributed to the rapid increase in copper production. The most marked increase has been made since 1908. Immediately before the commencement of the war there were indications that a period of great activity in copper mining was about to develop in response to the high prices offered by buyers and the prospects offered by new equipment schemes planned by many of the railroads.

The following table shows the steady progress made in copper production during the past thirty-five years:

WORLD'S COPPER PRODUCTION 1880-1915
(IN SHORT TONS)

Year	Tons	Year	Tons
1880.....	180,000	1909.....	942,408
1890.....	300,000	1910.....	966,998
1900.....	550,000	1911.....	969,750
1905.....	770,000	1912.....	1,114,769
1906.....	788,492	1913.....	1,104,517
1907.....	798,205	1914.....	1,120,000
1908.....	835,623	1915.....	1,110,000

These figures indicate an extraordinarily steady advance in the production of metallic copper. They also indicate that there is a tendency for copper production to be doubled each decade.

The chief copper producing countries are the United States, Japan, Spain, Mexico, Australia, Russia, Chile, and Canada, in the order named. But the United States' production is greater than the annual production of all the above named countries combined. Last year's production in the United States was estimated at 600,000 short tons. The combined production of the other countries mentioned was about 340,000 tons. All of these countries are increasing their annual production, but not in the same ratio as the United States and Japan. Japanese production has advanced from 33,000 tons in 1904 to over 80,000 tons last year. The production in the United States in 1904 amounted to 400,000 tons, as

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compared with last year's production of 600,000 tons.

A comparative study of the copper production of the various countries shows that only slight annual increases are made even in times when high prices prevail. The production in Chile, Russia, and Japan is increasing as a result of the investment of large amounts of fresh capital in the new mines and new metallurgical works. Production in the United States has likewise been stimulated by the same means. Production in other countries has been almost uniform for a number of years, and it is quite evident that, if the world's copper output is to be increased to meet any new demands, it will be necessary to force production by a large increase in mining investments in the principal producing countries. Price increases in metallic copper and its products do not appear to have much influence on production generally. Their influences seem to be felt chiefly in the larger producing countries, particularly in the United States. It appears that the United States producers, being such large factors in the copper marketing world and having, in a large measure, control of prices, are able to anticipate future demands better than producers in other countries, and, therefore, they are able to develop their mines ahead so as to prepare for increased production whenever the demand arises.

In the immediate future we may look for increased production in Chile, Russia, and Alaska. Two American companies, the Braden and the Chile Copper Mining companies, are operating mines in Chile which are capable of returning large yields. The Braden mine produces about 10,000 tons of copper per annum. The Chile company's Chuquicamata Mine is expected to produce about 50,000 tons of copper per annum when running to full capacity.

A large amount of capital has gone into copper mining operations in Alaska in recent years, and, in the near future, this should result in augmenting the output of the United States.

Russia has an enormous mineral area, and when capital is available for mining investments many of her copper mining districts can be made to yield much larger returns than at present. Russia's copper production averages about 60,000 tons per annum; that is to say, its yield is only a tenth as large as that of the United States.

The chief consumption of copper is in the United States, Germany, England, and France. The growth of consumption in recent years both in America and Germany has been extraordinary.

The following figures indicate the copper consumption of the principal countries:

ANNUAL COPPER CONSUMPTION

United States	342,000	tons
Germany	265,000	"
England	145,000	"
France	118,000	"
Austria	50,000	"
Russia	41,000	"
Italy	32,000	"
Rest of Europe	25,000	"
Total	1,018,000	tons

The total annual production of copper in Germany averages about 32,000 tons as against a consumption in 1914 of 265,000 tons. German and Russian consumption increased over 50 per cent in the past six years. The French consumption, in the same period, increased 25 per cent; while the British consumption showed a relatively smaller growth. In the next ten years, however, it is probable that there will be an extraordinary general development in copper consumption.

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Lead Production

The world's lead production averages about 1,100,000 tons per annum. It has shown the same tendency to increase in recent years as copper has. The total production in 1907 amounted to 1,000,000 tons and last year it was 1,200,000. In reviewing lead production, it should be borne in mind that while its production is slightly greater than that of copper, lead is a much rarer metal than copper. Whereas copper deposits are very widely distributed throughout the world, workable lead districts are not numerous. The leading producers are as follows: United States, 400,000 tons per annum; Spain, 240,000 tons; Germany, 200,000 tons; Australia, 114,000 tons; and Mexico, 120,000 tons.

The following table gives the world's production during the past sixteen years:

LEAD PRODUCTION 1900-1915

Year	tons (Metric)	Year	tons (Metric)	Year	tons (Metric)
1900.....	850,000	1906.....	986,980	1911.....	1,069,289
1901.....	900,000	1907.....	1,010,605	1912.....	1,050,000
1902.....	902,000	1908.....	1,057,205	1913.....	1,100,000
1903.....	916,800	1909.....	1,056,326	1914.....	1,120,000
1904.....	957,427	1910.....	1,093,144	1915.....	1,200,000
1905.....	988,800				

New uses for lead continue to be found. Since 1907, the price of lead has been low, and this, no doubt, has helped to maintain a normal production. Over a quarter of the annual production of lead is converted into white lead and oxides. It is true that zinc, barytes, and lithopone are largely used in place of lead in paint making. They are for many purposes inferior to lead and their use is justified only on the grounds of cheapness. As long as the price of metallic lead remains low, it will not be supplanted in the paint industries by any of its substitutes. At any rate, the general growth of the electrical industries all over the world will compensate for any diminishment in lead consumption in the paint industries.

Zinc Production

Zinc, like lead, is a metal that has only a limited geographical distribution. Over thirty per cent of the world's supplies of zinc ores are mined in the United States. And over 60 per cent of the United States zinc production comes from Missouri. Colorado, Montana, Wisconsin, and New Jersey are the other important zinc producing states.

Germany, with a production of 300,000 tons per annum ranks next to the United States. Belgium's output in normal times is about 230,000 tons.

Zinc mining statistics indicate that increased production is only noticeable in those important producing countries mentioned above. Should any sudden demand be made for zinc, it must be met by increasing the production in the United States, Germany, Belgium, and, perhaps, Spain. It appears probable that the United States production will soon be largely increased. During the past six years the zinc smelting capacities of American works have been largely augmented, and at the present there are about 120,000 zinc retorts in operation.

Tin Production

The world's tin supplies are obtained chiefly from the Straits Settlements, the island of Banka, Australia, China, Tasmania, and Bolivia. The total production is about 115,000 tons per annum. It is practically station-

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ary, notwithstanding the price of tin, since 1911, has been exceptionally high. It has been shown that high prices will not stimulate production because of the limited ore deposits. The result of this is that substitutes for tin are being extensively employed. Zinc and aluminum are the principal metals thus used.

MANGANESE PRODUCTION

Manganese is widely distributed. It occurs in extensive deposits in many countries, often accompanying iron-ore deposits. There are, however, only a few special demands for it, and, hence, production is restricted. The principal demand for manganese at present is for making steel alloys. A smaller demand comes from the chemical industries. The annual production of ore is about 2,200,000 tons, over half of which comes from mines in Russia. India, Brazil, the United States, and Spain are the other large producers.

The above cursory review shows that just prior to the outbreak of the war, the production of the common metals was on a record scale. Practically all the important metals were being produced extensively. But the high prices prevailing for some of the less common of the useful metals, such as nickel, tungsten, and tin, did not stimulate their production owing to there being too little capital invested in the mines producing them.

THE ECONOMIC OUTLOOK

The war industries are creating an abnormally large demand for many metals. Iron, copper, zinc, nickel, manganese, and all the metals used in steel alloys are in great demand and will continue so until the war is over. What then will be the course production will take?

The war is so extensive and is dislocating commerce over such a large portion of the globe, that it is impossible to apply old precedents in establishing forecasts regarding commercial tendencies. It is, however, certain that money will be in great demand in the victorious countries. That means interest rates will be high. In the defeated countries there will be a severe depreciation in the currencies owing to war debts and indemnities. These will cause trade depressions in the countries involved. The victorious nations will, immediately after the war, commence to repair the damage done during the fighting and will make strong efforts to secure the foreign trade of the defeated nations. Even should interest rates and commodity prices in the victorious nations be high, there will be much commercial and industrial activity, and the less fortunate nations will be compelled to repair some of the material damage done during the war. This will assure a great demand for iron, copper, and the other important metals, timber, building materials, etc. And there will be great demands for metals for ship building. This will all result in an enlarged mining production. Whether such production will be permanent, or purely temporary, will depend entirely upon post-bellum conditions, particularly with regard to finance.

The war will destroy much capital, and sentiment will largely rule the use of what remains. The world's productive capital chiefly consists in the knowledge possessed by its trained men; in its developed national resources; in its drained, enclosed, and cultivated fields; and in its roads, railways, ships, buildings, factories, machinery, and accumulated supplies. Only a small proportion of these will be destroyed by the war. The bulk of them are not and will not be brought within the war areas.

The war is absorbing the current savings and incomes of the nations

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involved. It is consuming their available stocks of goods, and it is destroying large numbers of their trained industrial and commercial workers. It will take some years to make good such losses and also to repay loans floated in order to affect the purchase of goods and munitions from foreign sources.

The most serious losses in capital will be in the assets of financial institutions. These are in the form of deeds, bonds, stocks, and securities which represent merchantable goods. As such securities are not in much demand during the war, their prices will tend to fall; sales at the end of the war will intensify their fall and result in a great depreciation when post-bellum prices are compared with those prevailing before the war. This means that there will be extensive individual losses through forced selling; but it will not mean a loss of national capital, except where the goods represented by securities have been actually destroyed or consumed. The principal part of the depreciation in securities will be recovered later by means of accretions of interest. This recovery period will be influenced by financial sentiment to a large extent.

Some countries will be in a better position than others to resume their everyday work and commerce. There will be commercial and financial developments corresponding to national emotional states arising from the resumption of peace conditions. It is quite evident that England will be in a highly favored condition following the war, provided she retains command of the seas. So long as she does that, no important injury can happen to her. By retaining such command, her credit will continue good and her commerce will be in a position to expand very rapidly. This will result in national prosperity which will benefit many of the neutral countries. Similar conditions would prevail in the event of the Teutonic powers succeeding, provided that their economic powers were not too badly injured by the conflict.

It is probable, therefore, that the war will be followed by great commercial activities in the successful nations and in neutral countries. And this will result in large demands for capital, high interest rates, inflation with its concomitant speculation, and high commodity prices. Under such circumstances, we may expect a large investment of new capital in metal mining, increased outputs of metals, and the introduction of new mining and metallurgical methods and processes through the stimulation of the large profits gained in the metal industries. How long such conditions will last will depend entirely upon the speed with which capital circulates. If investments and speculative commitments are made with feverish haste in the principal countries, the post-bellum prosperity will be short-lived. If, on the other hand, developments are carried out in a conservative and orderly manner, it may be some years before the injurious effects of the war upon the world's accumulated capital are seriously experienced in commercial operations. In any event, the demands for all the common metals, which we may assume will certainly follow the ending of the war in some countries, if not in all, to restore the destruction done in the commercially productive portions of the war zones, will be imperative and extensive. These demands will cause not only increased metal production but high metal values; and these in turn will cause prosperity in the mining and metal industries, the establishment of new metallurgical industries, and the opening up and development of new mines and mining districts throughout the world.

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EDITORIAL COMMENT

BLOCKING PROGRESS

JUST because certain features of the Taylor System as installed in the Watertown Arsenal have alarmed Organized Labor, the labor officials at Washington are promoting legislation at this critical time which will do more to block progressive enterprises than a general walkout.

The great appeal of Organized Labor to workmen has been for a united front in the demand for increases in wages. The greater the membership, the greater the chances of success. Men working under the Taylor or any other system of scientific shop management are disinclined to heed the appeal to join the Unions, because by the natural working of those systems they may automatically obtain an even larger return than Organized Labor can hope to get for them. The better grade of workmen, who may have worked under some system of scientific management, appreciate its beneficial operations and, hence, do not care to affiliate themselves with an organization which frankly seeks to put all work of a class upon the same plane.

The fight has centered about Government shops, for Organized Labor has realized that by obtaining governmental condemnation of scientific management they would have a powerful lever to force its principles out of other industrial establishments.

Partially successful last year by the passage of the Dietrick amendment to the army appropriation bill, which, in effect, prohibited time studies and premium payments in Government establishments and in private concerns manufacturing for the Government, its propounders will make strenuous efforts during the present session of Congress for even more drastic prohibitory laws. The amendment passed, after much debate, last year applies only to the fiscal year ending June 30, 1916. But it is now proposed to embody in the naval, military, and fortification bills in the present Congress a clause that will prohibit the Government not only from employing any system involving either time studies or premium payments in its own establishments, *but also from letting any contracts under those three budgetary bills to any private establishments where any such systems are in use.*

At this time, when the whole country is aroused to the need of military and naval preparedness, and when every effort should be made to encourage industrial progress, could any more retrogressive and injurious legislation be imagined?

Manufacturers or, in fact, business men in whatever walk the country over, should act immediately in combatting this proposed legislation. The former because they themselves may be debarred from competing for the large variety of army and navy contracts Congress will undoubtedly warrant; the latter because the lowest bids for these contracts can only be made by concerns operating under scientific principles. General Wm. Crozier, Chief of Ordnance, in a recent address pointed out that four years' experience in the Watertown Arsenal has shown great reductions in the cost of work and in the time

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required for its completion and a substantial increase in the earnings of the men. Surely, such being the case, would it not be consummate folly to turn back the wheels of progress at this critical time?

NORTH AMERICA'S "INTERNATIONAL COURT"

ONE reaction of the terrible war in Europe presents itself as a bright side. The very ferocity of the struggle in the Eastern hemisphere seems to have intensified the determination of all responsible countries in the Western half of the world that they will never be parties to any such sordid neighborhood quarrel. We have refused to take aggressive steps in Mexico and this act with others is steadily melting away the cold suspicions which our great size and occasional expropriations have solidified in the minds of our southern neighbors. The most inspired and inspiring passages in the recent message of the President are those concerned with Pan-Americanism the welding of unbreakable bonds of friendship between all the nations of North, Central, and South America.

We hear frequent talk of an international court as the result of this war. Probably some such scheme may eventually work out. It is inconceivable that trial by conflict shall always be the means of settlement of international disputes. The possibility of amicable settlement is proved by the relations existing between this country and Canada. One hundred years of unbroken peace along the four thousand miles of international boundary, the longest between any two countries in the world, constitutes one of the brightest pages in the world's history. It is not generally known that the preservation of this peace has been for six years practically in the hands of an International Joint Commission. This Commission appointed in January, 1909, is charged especially with the settlement of disputes arising out of the use of the many waterways that are included in the boundaries of the two countries; its decision in such cases is final; but it is also empowered to pass on any other international questions that may be brought to its attention, although with less authority. The importance of the work which the Commission has carried out in the six years of its existence is too little recognized.

The significance of this Commission cannot be too much emphasized. It represents the first successful permanent application of the principle of arbitration and of the international court and it is the most definite achievement in the direction of Pan-Americanism yet recorded.

MANUFACTURING COSTS

IN April, last year, Mr. Ficker left with us the manuscript for his series on Manufacturing Expense Distribution, the first chapter being published in June. The summation of Mr. Ficker's work appears in this issue, and his findings are that the orthodox methods of distributing costs have always been wrongfully assessed against the output regardless of the amount of the burden on idle equipment. In June, Mr. Gantt read a paper before the American Society of Mechanical Engineers, in effect very similar to the conclusions given in the paper he presents in this issue, that the output of a factory should bear only that portion of the total factory expense actually required in producing it. Until a few weeks ago Mr. Ficker and Mr. Gantt were unacquainted. The simultaneous conclusions of each, therefore, are significant, and indicate that the fallacious older method of cost distribution must go.

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WHY THE NAVY NEEDS A RESEARCH LABORATORY

OVERWHELMING ARGUMENTS LED NAVAL BOARD TO URGE ITS ESTABLISHMENT

SOME rather petty criticism followed Secretary Daniels' announcement of a board of engineers and inventors to be mobilized in the service of the Navy, and this was increased when the establishment of a great research laboratory was determined upon. All of this criticism was either ignorant, malicious or self-seeking. It has already been pretty well refuted by both argument and event; the most complete exposition of the purposes of the new Board, however, and a sufficient answer to all fault-finding is embodied in an address delivered before a joint meeting of the American Chemical Society and the American Electrochemical Society on December 10th of last year, by Doctor L. H. Baekeland, himself one of the most distinguished members of the Consulting Board.

Doctor Baekeland notes the utter dependence of modern warfare on science and engineering, evidenced by the successes of Germany and the organization in England and France of bodies similar to the Consulting Board. As a case in point he says: "Germany would be hopelessly paralyzed, did she not find in modern chemical processes of synthetic nitric acid from the air, the source of supply of this indispensible material. How otherwise could she manufacture smokeless powder and explosives, since England succeeded in shutting her off from the general source of supply of nitrates from Chile?"

The Board is now divided into committees and sub-committees ready to consult with any of the Navy chiefs as the latter feels he needs information on any subject, and to act as a go-between in obtaining the assistance of any member of the different societies represented. "For instance, a subject relating to improvements in the manufacture or the composition of a certain explosive, would be referred to the sub-committee on Chemistry and Physics, as well as to the sub-committee on Ordnance and Explosives; the matter is discussed in these two committees and the members of these two committees decide whom to select among their fellow members of the chemical or engineering societies who are best qualified to help them in this task, and who, at the same time, are willing to co-operate without any other compensation than the feeling that they are working for the good and the security of the Republic."

The decision to recommend the establishment of a research laboratory was the outgrowth of discussion based on the experience of the Board members. A preliminary "modest estimate for a merely chemical and physical laboratory was snowed under by the irrefutable evidence of the much larger needs for a suitable

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mechanical or engineering department."

Doctor Baekeland sums up thus the need for the laboratory: "If it is deemed urgent to be prepared for defense, then this defense involves problems the solution of which cannot be deferred indefinitely. If something has to be done, it must be done immediately—not in five or six years hence, when it may be too late. In all of our present scientific research laboratories, time seems of relatively little or no account; problems which cannot be solved today can be solved tomorrow, or in ten years, or during the next generations; but this is not the case with the problems connected with the contemplated defense of our country; the solution of these problems cannot be postponed. They demand immediate action. Nor is the condition of our Navy similar to that of an industrial concern that can afford to take chances with machinery or equipment which is not strictly up to date, and still show some commercial success. . . . . Our Navy cannot afford to use anything but the very best and most efficient means of defense. . . . .

"The contemplated outlay for the Navy for the next five years, for new ships, aviation and reserve of munitions, amounts to about $500,000,000. These tremendous expenditures of money, in order to be of real value, ought to be made as efficient as possible. All doubtful or inferior devices must be eliminated by direct experiment, by research and tests, *before* it is too late to remedy them. This requires accelerated action; in fact, Mr. Edison's personal opinion was that research and laboratory work in this instance 'should go on night and day without intermission' instead of the usual easy-going short day plan followed in laboratories. If one single automobile concern in the United States finds it to its advantage to spend in one year half a million dollars on testing, research, or experimentation, how much more important is the business of the United States Navy, where money not spent wisely is better not spent at all, because then at least, we shall not have the illusion that we are equipped for defense, when we have merely lost our money on antiquated devices.

"Without mentioning any spectacular problems of modern warfare, it might be stated that such a detail as the corrosion of condenser tubes of our warships involves an annual damage of about $2,000,000. If $1,000,000 were spent on research on this problem alone, with the result of reducing the damage to one-half, the total outlay would be compensated in a few months' time, aside of the important fact that our fleet would be stronger because less of our ships would be unavailable for service. It was brought out that there was little use in spending so many millions on flying machines as long as there was any doubt on the reliability of their engines, and until an absolutely well tried and standardized engine had been developed. . . . . .

"Another member brought out the fact that even conservative industrial enterprises found it necessary and profitable to spend at least two to five per cent of their sales on research and experiments. At this rate, the contemplated expenditure of $500,000,000 in five years, would certainly warrant an expenditure of at least five million for research."

Doctor Baekeland concluded his address with the reading of excerpts from a speech delivered by the late Rear Admiral Melville over a decade ago in which that eminent engineer urged in the strongest terms the necessity for establishing just such a laboratory as that now undertaken.

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ELECTRIC PROPULSION FOR THE CALIFORNIA

ADVANTAGES IN ECONOMY OF STEAM AND IN SIMPLICITY

AT regular intervals the charge is made that our Naval designers are followers, not leaders; that they look to England for their models as dress designers look to Paris; and that our ships are always several years behind the best practice. It may be that this charge has a basis of fact but it is well to bear in mind certain other facts: That the United States has not always been backward in the design of fighting ships, the iron clad and the turret may be fairly credited to America; and that today we are engaged in the construction of the first battleship with electric transmission of power from engine to screw, just as we were the first nation to use such transmission on any Naval vessel, namely on the collier Jupiter.

A complete description of the California, for which the keel has recently been laid, and which is to have motor drive for her propellers is not yet available, but in a paper before the Society of Naval Architects and Marine Engineers, William LeRoy Emmet gives some interesting notes on her propelling equipment. It is interesting to note that Mr. Emmet is one of the members of the newly selected Naval Consulting Board, a position for which he is eminently fitted.

The California is to have a displacement of 32,000 tons and a speed of 22 knots, requiring 37,000 shaft horsepower. She belongs to the largest and most powerful class adopted by the United States. Her electric propelling equipment is to be built by the General Electric Company. "The contract with this company," Mr. Emmet states, "covers two turbine-driven generating units, four propelling motors (one for each shaft), switching apparatus, cables, instruments, etc., two turbine-driven exciting units, and a complete equipment of condensing auxiliaries and ventilating blowers, all driven by motors from the exciting units."

The estimated weight without condensing auxiliaries is 530 tons and the contract price with auxiliaries is $431,000.. "The generators are bipolar alternators," continues the description, "and the motors are arranged to be connected either for 24 poles or 36 poles. For economic cruising at 15 knots or less, one generator will be used with motors on 36-pole connection. For higher speeds the 24-pole connection will be used. The ship will be capable of operating at a speed of about 18.5 knots with one generator."

Variable speed governors on the turbines will prevent racing and make it possible to hold a fixed speed regardless of external conditions. Under heavy penalties, the following steam consumptions have been guaranteed: At 10 knots, 14.6 pounds; at 15 knots, 11.4 pounds; at 19 knots, 11.1 pounds; at maximum speed, 11.9 pounds. The propellers will make 175 revolutions at full speed. For sister ships with Parsons turbine drive, the proposed propeller speed is 240, which should give the California an advantage of about 9 per cent in propeller efficiency. An interesting comparison is afforded between the California and other large battleships, such as the Florida and the Utah with Parsons turbines and the Delaware with reciprocating engines, the California showing far better steam economy than any of the others at all speeds.

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TRUTH ABOUT RHODE ISLAND COAL

HISTORY, CHARACTER, ENCOURAGING POSSIBILITIES, OF A NOTORIOUS FUEL

PERIODICALLY in recent years the public has been asked to invest in the exploitation of Rhode Island's coal deposits. Those who heeded the call, rued it. Rhode Island coal has taken its place with gold mines, oil wells and rubber plantations as among the most effective agencies permanently to separate feeble-minded speculators from their funds. Yet it is not strange that the possibilities of these fuel deposits have proved a strong attraction, situated as they are in a region densely populated, highly organized industrially, and relatively remote from cheap power. It is a safe prediction that they will some day prove useful.

Consequently, the United States Geological Survey in making a study of the beds from both the geological and the economic point of view has done a valuable service, and the result of its findings presented in *Bulletin* 615 should be a matter of interest to all.

For a century and a half a countless series of attempts have been made to utilize this coal and with uniform non-success, except in the case of the Taunton copper smeltery. The Survey comments on these failures as follows:

"The apparent failures to mine the coal profitably appear to be due to four causes—first, improper preparation of the coal at the mines; second, attempted use in and with furnaces and with apparatus built for use of dissimilar coals; third, relatively low duty obtainable from the coal in comparison with competing coals per dollar of cost, and the special and particular handling required; and fourth, stock jobbing. The attempt, for example, to burn Cranston coal in large sizes, fresh from the mine, in an ordinary furnace is doomed to disappointment."

The coal is described as "extremely variable in character and quality, ranging from anthracite to graphite, and containing moderately high ash to very high ash, and usually a high percentage of moisture when first mined. Because of its peculiar characteristics, all the coal requires peculiar handling to be used successfully, and the extremely graphitic portions can hardly be used as fuel."

As for future possibilities, the Survey has this to say: "To attempt to sell Rhode Island coal in the open market under present conditions is almost certain to result in failure. The public at large has lost faith in this coal as compared with other coals used in New England, partly because of its weight, making it appear small in bulk when delivered, partly because of the excessive amount of ash carried by most of it, but mainly because of the lower duty it usually renders when burned in the ordinary way. On the other hand, the sale of Rhode Island coal as electricity, ready for use by the turn of a switch, will avoid any possible prejudice or any failure because of improper use, and will avoid freight charges on the ash. Such use, therefore, possibly through the medium of the gas producer and gas engine, seems to be the proper aim of future successful exploitation. This use means a few plants specially built and specially manned. So utilized, it is believed that Rhode Island coal may afford a large field of profitable investment."

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SYNTHETIC RUBBER*

PRESENT STATUS OF ARTIFICIAL PRODUCTION PROCESSES

The Horseless Age

IN 1905 Harries determined the chemical formula of natural rubber. In 1909 Hofmann and Coutelle made rubber from isoprene by heating in a closed tube. A year later Harries reported a similar success, heating, however, in the presence of glacial acetic acid. The work was taken up by others and rubber produced from other hydrocarbons similar to isoprene. By heating with different substances it has been found that a series of rubbers is obtainable which differ largely in properties.

Synthetic rubber has been produced from butanes, constituting a certain group of hydrocarbons, from isoprene and from dimethylbutanes. The process of changing over, called polymerization, can be performed in the presence of metallic sodium, or in an atmosphere of carbonic acid with metallic sodium, or with the use of ozonizers on peroxides as catalizers. The resulting rubbers will vary widely as to their solubility, elasticity, susceptibility to vulcanization and inflatibility. Thus rubber produced from a butane by the sodium process is easily soluble, elastic and capable of being vulcanized, while one made from dimethylbutane by the ozonide process is inflatable, soluble only after calendering, non-elastic and can be vulcanized only as hard rubber.

The variations in qualities of different synthetic rubbers gave rise to the hope that by slight changes in treatment, rubber with any desired combination of properties could be easily produced. The commercial importance of rubber synthesis is a different matter; to rival natural rubber, synthetic rubber must equal it in both price and quality. The price will in turn depend chiefly on the cost of the hydrocarbon of which it is made and this cost would naturally rise as the demand for the commodity increased. Starch, amyl alcohol, turpentine, acetylene, are other raw materials available. But the present rubber production of the world, about 100,000 tons a year, would require for its synthetic duplication the planting of an area of corn or potatoes many times the area now in rubber trees. The disposal or utilization of the resulting byproducts would be a serious problem. At present there is no possibility of serious competition with natural rubber in price.

While it is easily imaginable that artificial rubbers might be produced with certain special qualities that would let them sell at an advanced price over the natural product, this lies in the future. In general, while complete information is lacking, synthetic rubber would appear inferior to the natural in durability. This is because the latter contains resins, etc., which resist the action of the air; it is known that deresinized natural rubber is more easily attacked than rubber containing resin. Another reason for the inferior mechanical properties of synthetic rubber is the fact that it is a mixture instead of a uniform compound; in the process of transformation, certain compounds are formed that have not yet been found in natural rubbers. Until manufacturing processes are able to turn out a uniform compound, the synthetic rubbers will remain inferior.

* Translated from a discussion by F. W. Hinrichsen in the *Zeitschrift des Vereines deutscher Ingenieure.*

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RAISING THE SUBMARINE F-4

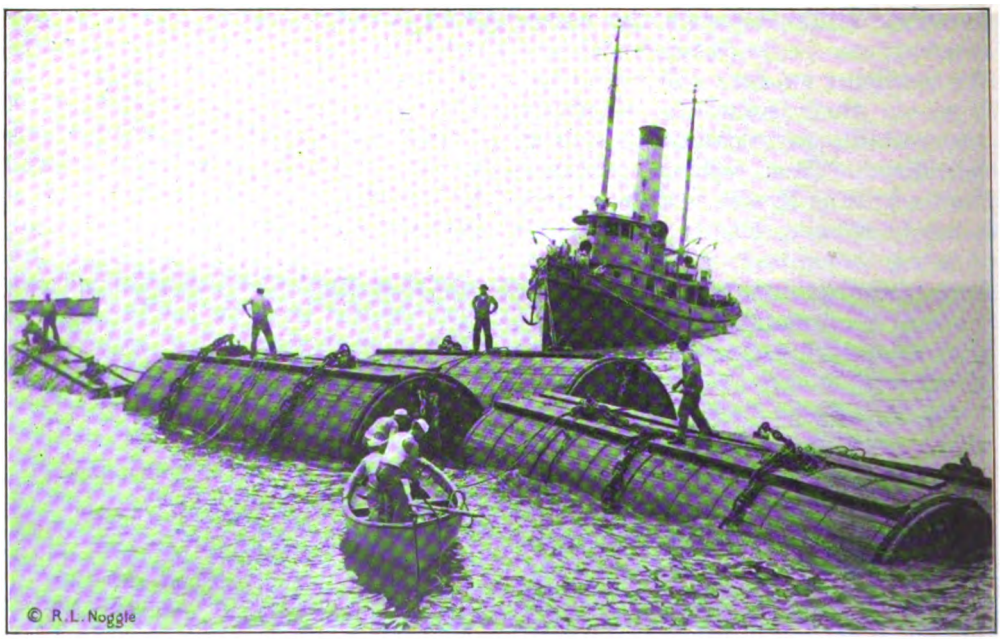
SCOWS USED FOR DEEP WATER AND PONTOONS TO FINISH THE JOB

INTENSE national interest and concern followed the wreck of the submarine F-4 off Honolulu last March and the drowning of her crew. The human interest of this story has obscured the technical importance of the salvaging job which was recently brought to a successful conclusion. The details of the difficult operations as described in *Engineering News* by Naval Constructor J. A. Furer, who was in charge of the work, make fascinating reading to the engineer.

"Much larger totally submerged vessels," writes Mr. Furer, "have been raised from shallow water, but none has ever been brought up from a depth of 300 feet. A few smaller vessels have been raised from depths of 200 feet, but only out of enclosed waters. The previous record for depth was the salvage of a small wooden tug, weighing perhaps 125 tons submerged, which sank in about 250 feet of water in Puget Sound. The weight to be lifted in the case of the F-4 was 260 tons.

"The principal difficulties of the salvage problem were the great depth of water in which the vessel lay, the weight which had to be lifted and the open-sea exposure. The vessel sank in 300 feet of water outside of Honolulu Harbor, where there is no protection from southerly weather."

The first operations undertaken involved lifting the boat by cables hoisted by scows on the surface, the cables being swept under the hull by tugs, and divers used for inspecting and reporting only. Difficulty was had



F-4 SUSPENDED FROM PONTOONS AND READY FOR TOWING

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in getting heavy enough cable; two 2½-inch galvanized-wire hawsers, one 2⅝-inch plow-steel and one 2-inch plow-steel were finally obtained. For hoisting equipment on the scows, sugar-mill machinery was obtained and partly rebuilt. On account of its available machinery a dredge was used to hold temporarily the ends of the cables after they were swept under the boat. The divers set a new record for depth, this being possible because of experiments conducted by the Navy Department just previous to this work.

"The diver," as Mr. Furer describes him, "does not wear a suit of special character for working in great depths. The difference as compared to shallow-water procedure lies entirely in the method of supplying air to the helmet and in the scientific restoration of the diver's body to the normal state by gradual decompression as he comes up from deep water. Air is supplied from flasks charged to a high pressure—suitably reduced before being delivered to the diver's helmet. The dangers of deep sea diving are due principally to the absorption of nitrogen by the fluids of the body, on account of the high pressure to which the lung tissues are subjected, and to the extreme exhaustion accompanying any kind of manual labor. For the latter reason the divers could not do heavy work at the 300-foot depth, such as can easily be done by men working in shallow water."

Difficulties were had in attaching the cables and with their breaking after attachment; chains had to be substituted for the cables under the hull, since the latter chafed and parted; the work progressed however, the cables being wound up on drums on the scows, and, at the same time, the lifted submarine being moved into shallower water. In this manner the submarine was got into water only 50 feet deep. Then there arose a heavy ground swell and the waves and undertow made the scows charge back and forth and to avoid damage to the submarine the slings were cast off and the scows towed to harbor.

The shallower water now permitted the application of another method of lifting, namely by pontoons. Six steel cylinders were built, four 11 feet in diameter and two 12½ feet, all 32 feet long. These were divided into compartments and sheathed with wood to prevent injury. After they had been towed to the submarine they

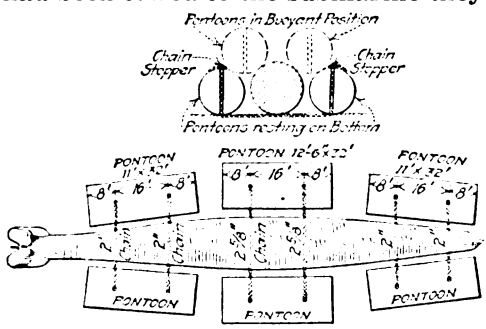

DIAGRAM OF PONTOON ARRANGEMENT

were sunk and chain slings were adjusted as shown in the drawing. This work was done by divers, which was feasible at the relatively shallow depths. When the arrangements were complete, the water in the pontoons was carefully blown out by means of compressed air from torpedo flasks reduced to 35 pounds.

The pontoons successfully floated the submarine to the surface and she was towed to dry dock. The photograph shows the pontoons and the submarine on the surface. It should be noted that the pontoon method would have been inapplicable during the first steps, since the great depth would have prohibited the work of the divers in fitting the chains to the pontoons, work which could not have been done from the surface.

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LORRAINE AND HER MINETTE ORES*

ECONOMIC IMPORTANCE OF THE IRON DEPOSITS AND THE REASONS OWNERSHIP SHOULD REMAIN UNCHANGED

H. H. Campbell—The Iron Age

WHEN the basic bessemer process for steel making was developed, the minette iron ores of Lorraine, theretofore despised, assumed commanding importance. It is because of this importance that the French now covet so keenly the territory lost to Germany in 1871, before the value of the ores was discovered. The adaptability of these ores for the making of basic steel has built up in Westphalia, where there is found the best coking coal in continental Europe, a great industry, including the works at Ruhrort, Hoerde, Dortmund and Essen. The steel production of Germany increased from less than a million tons in 1880 to over seventeen million in 1912. France and Belgium, as well, have shared the benefits resulting from the exploitation of the minette ores, while the grand-duchy of Luxembourg derives much of its importance from the share of the ores which it possesses; by special treaty the ore, pig-iron and steel output of Luxembourg is usually combined with that of Germany.

Forty years ago the low-grade ores were considered of little value and received their name of "minette" as a designation of contempt. The progress of metallurgy has changed their status and the meaning of the word is almost forgotten.

In German Lorraine, in the southern part of the Rhine Province, and in Luxembourg, the minette ore constitutes the entire burden of the blast furnaces and these districts make about 40 per cent of the pig iron in Germany. Eastern France makes nearly 70 per cent of the pig iron of that country and here as well as in the department of Meurthe and Moselle, minette ore is used exclusively. In Westphalia it accounts for about two-thirds of the pig iron made. The output of these districts in 1910 was over fourteen million tons, well over half the pig-iron production of continental Europe. Great Britain that year produced about ten million tons about half made from imported ores.

Figures on steel-making are always more difficult to obtain in accurate form, owing to the re-using of scrap. But in German Lorraine, in the valley of the Saar, in French Lorraine and in Luxembourg, all the steel is made from minette ore, while in Westphalia many works use this ore exclusively and in Belgium about 90 per cent of the steel is to be credited to it.

In the ten-year period preceding 1911, France, Belgium and Germany, considered either as a unit or separately, increased their iron and steel outputs more than the United States and many times more than Great Britain. It is clear that the minette ores are a great factor in the iron and steel industry and it is important to know how long the deposits will last.

The mineral is low in sulphur and high in phosphorus, giving 2 per cent in the pig iron. It is exceedingly variable in analysis over a vertical section, and the poor having to be taken with the rich in mining, the average run of mine will carry about

* *c.f.* THE ENGINEERING MAGAZINE, November, 1914, p. 161.

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31 per cent iron. The ore sent to Westphalia will run higher, since it has to stand the freight charge. The composition varies greatly in different parts of the field. Thus in German territory much of the ore will carry 20 per cent in lime, more than is needed in the blast furnace, while in French territory, the silica content is high, often running up to 25 per cent. The French ore, however, is higher in iron by 3 to 6 per cent. By proper mixture of the siliceous and calcareous ores a self-fluxing material may be obtained, but much of the siliceous ore is considered not commercial today.

The French ore reserves, mostly siliceous, are about three billion tons, and the German, mostly calcareous, are about one and a half billion. The total should produce about one and a half billion tons of pig iron. At the rate of production in 1910, this would last about 100 years, but production is increasing. Some time ago, it was thought that Germany had the best of the bargain with her calcareous ores, easily made self-fluxing, but of late the French have come to the conclusion that they are better off, with the higher grade material.

Recently Germany was accustomed to import iron ore from Luxembourg and French Lorraine and export to Belgium and France, both in large quantity. Free trade in iron ore existed between the countries of western Europe, Germany and France exchanging ores in order to get fluxing mixtures, while Belgium was a free market because of the selling competition between the other countries. France has declared its intention of annexing German Lorraine if the allies are successful. If it should do this it might be able to put a prohibitory duty on the export of iron ore and monopolize the whole supply except that of Luxembourg. In carrying this out as an economic measure it might deny that it desired to injure Germany but the result for that country would be disastrous, nevertheless.

The inhabitants of German Lorraine are not predominatingly French by any means, notwithstanding its recent conquest; German is the most commonly spoken language. Nor has France any historical justification for demanding the return of the province; it was German before it was French. And Lorraine is essential to the industrial development of Germany. For not only does it support the iron and steel industry, but from the basic slags with their phosphorus, an invaluable fertilizer is obtained and the whole coal-tar-products industry, including the analine-dye trade, is built up on the coking of coal for the blast furnace.

It is conceivable that Germany will dictate the terms of peace, and may demand some or part of French Lorraine. With the possession of the minette field, it would also take over two-thirds of the French steel plants. Then with a prohibitory export duty it could paralyze the steel industry of France and Belgium and monopolize the business of western Europe. It is to be hoped that this opportunity will not arise and that Germany will not avail herself of it if it does.

If France claims German Lorraine, or if Germany claims French Lorraine, we may strike the word "peace" from our lexicon. Such a provision would mean war. This might come in twenty years or in fifty, but it surely would come, a repetition of the present struggle with its attendant burden of war preparation. The natural resources of the minette region are divided now so as to give the neighboring nations a fair share according to their needs, and to disturb this equilibrium would be a crime.

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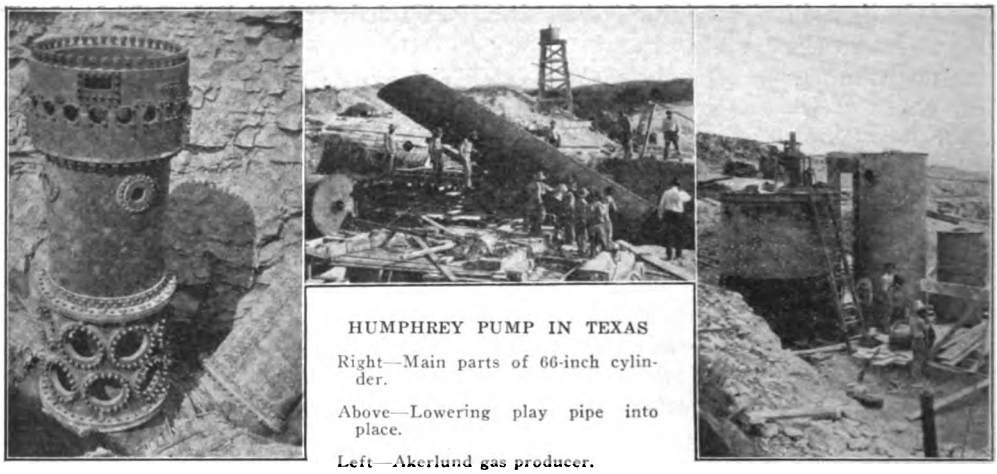

HUMPHREY PUMP IN TEXAS

Right—Main parts of 66-inch cylinder.

Above—Lowering play pipe into place.

Left—Akerlund gas producer.

IGNITION DEVELOPMENTS IN THE HUMPHREY PUMP

PROGRESS IN IRRIGATING-PLANT INSTALLATION IN TEXAS

ITS high efficiency and extraordinary simplicity have made the development of the Humphrey gas pump a matter of widespread interest. Its operation has been described before in THE ENGINEERING MAGAZINE, but the importance of the first large installation in the United States, that on the Moore estate in Texas, makes it worth while to call attention to a partial description thereof written by Charles C. Trump and appearing in *The Sibley Journal of Engineering*. Mr. Trump devotes most attention to the development of a new system of ignition, suited to the peculiar operating scheme of the Humphrey pump, which involves a mass of moving water in an extremely large combustion chamber.

"The principles of reliable ignition which are so vital to the success of an internal combustion engine depend largely upon the spark plug and timer," says Mr. Trump and goes on to describe the experiments he made with spark plugs. He concludes, "The compromise which has been effected is to use the standard automobile spark plug construction with a small opening in the sparking end as compared with the ordinary plug, and a conical projection on the porcelain insulator fitting closely in the hole. The center wire, porcelain and metal bushing may be ground off, time after time, to renew the smooth sparking surface and the plug kept in working condition under a heavy spark and in the presence of a rain of water and the heat of combustion in the cylinder. With the experience so far obtained it is expected that these plugs will operate continuously in the intermittent service for 48 hours without grinding and that each plug will give service for one month."

For the timing, the principle of the electric sign flasher is used. A bar of brass is carried on the moving parts so as to make contact only on the compression stroke and thus control the primary current in the transformers, which with their secondary current furnish the spark for igniting the explosive charge.

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SHIP BRAKE FOR QUICK STOPPING

EXPERIMENTS WITH SIDE WING TO BE USED IN AVOIDING COLLISION

PROBABLY never before in our history were marine matters in general so prominently in the public eye. Questions of Government ownership, the seamen's bill, naval development, South American trade, change of register, have combined with the large international questions arising from the policies of the European belligerents, to draw the attention of all thinking people to the subject of foreign commerce and the means of conducting it. Anything new, therefore, connected with sea travel is of interest, and particular importance attaches to a short paper by Captain William Strouther Smith, read before the Society of Naval Architects and Marine Engineers, on the results of experiments with a ship brake, inasmuch as such a brake is a safety device of considerable potential efficacy.

The device, known as the Lacoste ship brake, is designed to be thrown out from the side of a ship that is in danger of collision or grounding and thus add its resistance to the efforts of the propellers to arrest progress. Captain Smith notes that, "The question of installing such a brake is a financial one and is dependent upon the lessened insurance demanded and the advertisement of such an appliance to increase the passenger list."

Experiments with the apparatus were first made on the U. S. S. Indiana in 1910 but showed very little either for or against the brake. The loss of the Titanic awakened interest in the matter and arrangements were made with the Government to conduct experiments at the Washington Navy Yard with a model. The model followed the design of the St. Louis, which is 536 feet long with a displacement of about 17,000 tons and draft of 28 feet.

Using this model, a number of runs were made and valuable data obtained, the model having the great advantage of affording means for accurate measurement. Various forms of brake were considered, which had the object of permitting opening and closing at will with the vessel going at full speed. These were all judged too extravagant of weight and power and the final conclusion reached was that, "The simplest form of brake, designed to be set in the side of the vessel, to be released instantly by the officer on the bridge by throwing a lever and to open by the pressure of the water without further thought, to be supplied with only enough power and mechanism to haul in the brake when the vessel was stopped or going astern and lock it fast for future use, —was the only practical solution of the question."

It was found with a pair of brakes 11.73 feet wide and 14 feet deep, set at right angles to the direction of the vessel, the speed would be reduced from 18 knots to 7.15 knots in 2000 feet without the help of the propellers.

Accordingly, "A type design was made for the Empress of Asia, practical, strong and simple, for emergency use only. The officer on the bridge has but to pull a lever and the brake will open and exert its resistance. When the danger is past, it requires the attention of but one man on each side to haul in and secure the brake. With this done the technicist closes his work and the financier and promoter begins to write his story."

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NEW HAULAGE SYSTEM FOR OPENPITS

SELF-PROPELLED CARS CONTROLLED BY SINGLE OPERATOR

EXTRACTION of the broken material from large surface excavations has always been a somewhat vexatious problem. In quarries and in openpit mining, recourse has been had to derricks, cableways, inclined hoists and, most extensively, to locomotive haulage on tracks. None of these methods approximates perfection and great significance therefore attaches to the method devised by F. E. Woodford and described by him in a paper entitled "Centrally Controlled Electric Haulage Systems," presented before The Engineers Society of Western Pennsylvania, September 21, 1915, and printed in the October *Proceedings*, page 584.

The system is devised to replace locomotive haulage out of quarries and similar excavations and has already had several years of successful application in a number of different places. Mr. Woodford gives a general description of the method as follows:

"Each car carries its own motive power and control apparatus, taking current from a sectionalized third rail, which allows the car to be started and stopped, or have brakes applied at the will of the tower operator and the car to have its direction reversed at certain fixed points. Control apparatus on the car is arranged so that as the car descends grades the motors can be connected across resistance banks and the regenerative effect used for retardation purposes. The third rail, which extends over the whole territory covered by the haulage system, is divided into long or short sections, as conditions require, and an independent feeder is extended from the control tower to each section. The tower operator has two voltages, 250 and 90 volts, which he can apply to various sections of the third rail at will; 250 volts is used for haulage purposes and 90 volts is for braking purposes."

The system offers several advantages: First, a large saving in labor cost, the single operator replacing a number of firemen and engineers on locomotives; second, a reduction in the quantity of rolling stock, since the cars are employed more nearly continuously; third, economy in power, the dead weight of the locomotive being eliminated and the weight of the live load being added to that of the dead load to give better adhesion and more traction. The system is capable of indefinite extension and is consequently elastic. The cost of installation is stated to be about the same as for a steam locomotive equipment.

The central tower apparatus consists of a series of switches for exciting the several sections of track as needed. The operator can usually see a large part of the work in progress but is governed in his work by a signal system. A series of automatic stops and controls is provided, chiefly to prevent runaways downgrade, the dynamic brakes being thrown into action on any car that gets beyond control through a failure of current and permitting it to run down the grade only slowly. For manipulation of the cars about the loading shovel, a special local control is installed, to be operated by a man near the shovel; away from the shovel the car is wholly controlled by the towerman.

The discussion of the paper brought abundant testimony from quarry operators as to the efficiency and simplicity of the system.

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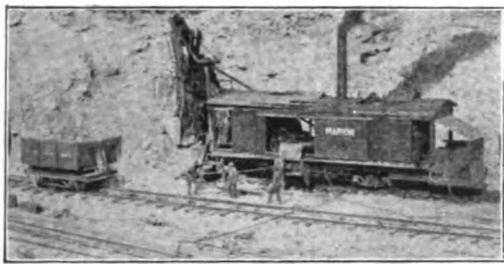
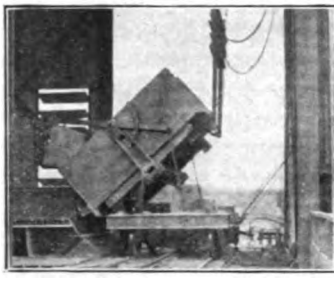
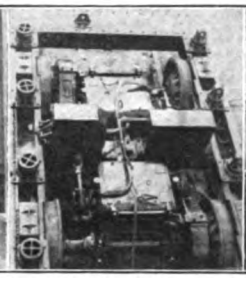


CAR NEAR SHOVEL
Under control of pit-man who is starting it after loading.

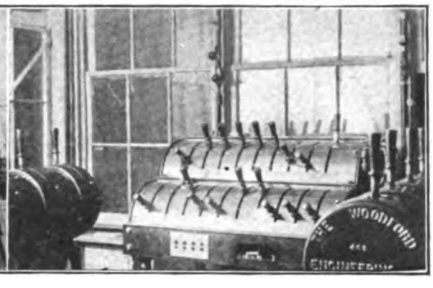
DOLESE & SHEPARD QUARRY AT GARY, ILLINOIS
Loaded car ascending 6 per cent grade.



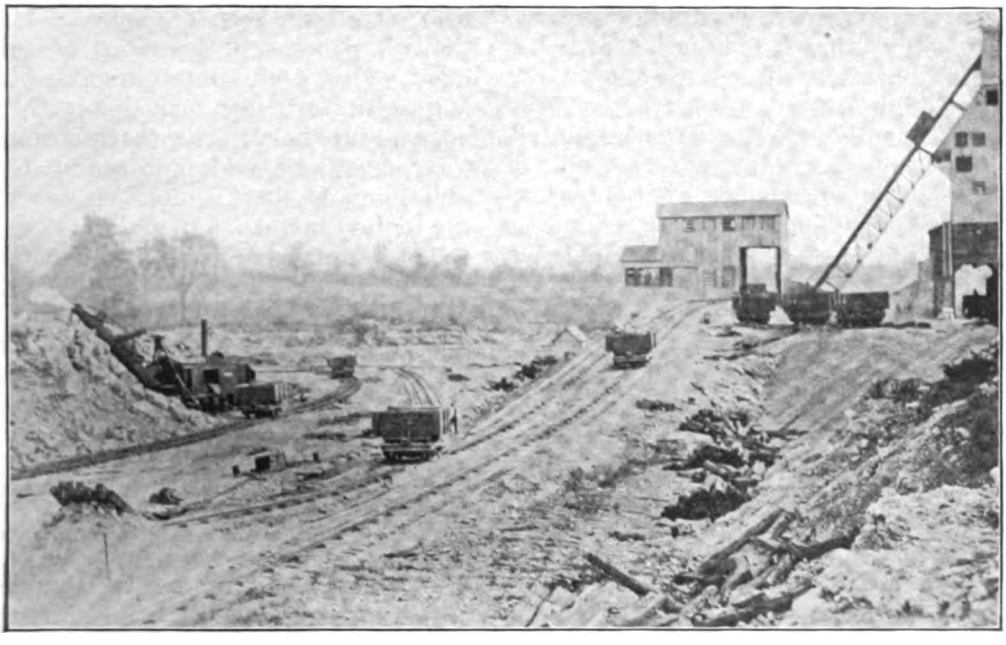
ELECTRICAL CAR DUMPER OPERATED FROM TOWER



MOTOR EQUIPMENT, SIX YARD-CAR TRUCK



PART OF THE INTERIOR OF A CONTROL TOWER



LAYOUT IN THE QUARRY OF THE CASPARIS STONE COMPANY AT KENNETH, INDIANA
Empty cars leaving plant and approaching shovel; loaded car approaching plant.

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SOME INTERESTING ALLOYS

NON-FERROUS COMBINATIONS WITH USEFUL QUALITIES

AT the September meeting of the American Institute of Metals there were presented a number of papers on binary and more complex alloys of metals other than iron, which have been developed or are in process of development.

Stellite, a cobalt-chromium alloy, used for machine tools was described by Elwood Haynes. Stellite is not new; but its qualities may well be more generally known. "The virtue of Stellite," says Mr. Haynes, "lies in its ability to maintain its cutting edge at a high rate of speed at temperatures which would immediately cause the failure of any known tools containing any notable quantity of iron. Its great hardness and resistance to abrasion at all working temperatures are likewise valuable properties."

It appears that the material is so hard as not to be capable of successful filing, that it is tough, that it has high elastic limit, say, 85,000 pounds and high ultimate strength, say 110,000 pounds and that it is absolutely resistant to oxidation. In some of the early specimens brittleness resulted; this has been eliminated so that now a ⅜-inch square tool will resist a transverse pressure of 1200 pounds applied to the end of a 1-inch projection from a clamp.

Since stellite retains its hardness even at a full-red heat, it cannot be forged. To bring it to shape it is cast in bars and then ground to an edge. It is not a steel and cannot be handled as such; failure to recognize this has sometimes led to difficulties.

As an example of what the material will do, it is stated: "It was recently ascertained that a ⅜-inch square by 2½-inch long piece of Stellite, ground to the form of a grooving tool, cut 14,000 grooves in cast-iron pistons ranging from 3½ inches to 4⅜ inches in diameter before it became too much worn for further use. This work was performed in regular practice and not as a test."

Vanadium has become a well recognized material for use in iron metallurgy. Less investigation has been made of its availability as an alloying element for other metals. W. W. Clark describes the results obtained from experiment in this field. To introduce vanadium into other metals, it should be already alloyed in definite proportion with some suitable metal. Copper has proved unavailable, since the vanadium melts at 1,732 degrees C. and is only slightly soluble in copper. Aluminum was tried, however, and found satisfactory. A thermit and an electrical method of manufacture have both been developed. The thermit process is described as follows: "Ingot aluminum is melted in a graphite crucible provided with a bottom tap hole. The thermit mixture of vanadic oxide and granulated aluminum is then ignited on top of the molten metal. After all has been reduced the mass is stirred and the metal tapped." For the electric method, "Cryolite, alumina, fluorspar and vanadic oxide are mixed and added in small successive portions to a furnace which contains molten aluminum. This mix is melted by means of the arc, after which the electrode is lowered and the mess electrolyzed. The aluminum is thrown out first, becoming richer in vanadium as the electrolysis continues and the slag becomes impoverished in aluminum. This alloy is tapped and mixed, when it is cast in small molds."

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The alumino-vanadium can be added to brass and to bronze and appears to have an appreciable effect in increasing their ultimate strength and their percentage elongation. In cases where aluminum is undesirable in the final alloy, mangano- and nickelo-vanadiums can be similarly made and used.

W. M. Corse called attention to some of the excellent qualities of aluminum bronze, that is, the alloy of copper and aluminum with aluminum below 15 per cent. The hardness of such bronze and its control by heat treatment is remarkable. The use of ordinary bronze castings is limited because of their softness. "Aluminum bronze alloys of approximately 10 per cent aluminum, however," according to Mr. Corse, "possess properties very similar to a Swedish bessemer steel of 0.35 per cent carbon, including the property of being hardened by heat treatment. For instance, heating this alloy to different temperatures up to 800 degrees C. will give on quenching, hardness numbers varying from 100 Brinell to 260 Brinell." Many uses suggest themselves for bronzes with hardness above 100. Thus after proper heat treatment they have given excellent results in bearings running 20,000 revolutions per minute, where softer bronzes were unable to hold their shape. Tests on a titanium aluminum bronze after the proper heat treatment gave elastic limit, 56,700 to 39,300 pounds; tensile strength, 96,700 to 91,200; elongation, 5.5 to 14.0 per cent; hardness, 158 to 140 Brinell. Another valuable property of these bronzes is their resistance to fatigue. "Comparing aluminum bronze with manganese bronze of the same strength," it is stated, "we found that the aluminum bronze resisted stresses above its elastic limit for an average of 15 million reversals in a White-Souther machine, while manganese bronze broke at less than 1 million. From an engineering standpoint this is very important because the test of the fatigue of a metal is really the nearest to the service test that we can make with our present facilities."

The increasing price of platinum due to its absurd use in jewelry has long been a source of disquiet to chemists and other technicians, platinum ware possessing qualities exceedingly valuable and quite unique. This disquiet has been heightened by present war conditions, the price of the metal having now risen to almost three times that of gold. It is evidently very desirable to find a substitute or at least a partial substitute. Particular importance therefore attaches to an investigation carried out at the University of Illinois and described by S. W. Parr.

An attempt was made to discover a resistant alloy, working on the assumption that by a suitable adjustment of electro-positive and electro-negative properties in a series of metals, they could be made to neutralize one another. A fair degree of success was obtained, an alloy being finally developed from which six castings out of seven did not exhibit a weighable loss after contact with 25 per cent nitric acid for 24 hours. The analysis of a representative sample of this showed: Copper, 6.42 per cent; manganese, 0.98 per cent; silicon, 1.04 per cent; tungsten, 2.13 per cent; nickel, 60.65 per cent; aluminum, 1.09 per cent; iron, 0.76 per cent; chromium, 21.07 per cent; molybdenum, 4.67 per cent.

The alloy has a high melting point and is difficult to cast without developing shrinkage cracks. However, it was made sufficiently dense to stand a pressure of 25 to 30 atmospheres in a calorimeter bomb.

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RECENT ELECTRIFICATION

MANY PROJECTS COMPLETED AND ADVANCED DURING 1915

PROGRESS in electric traction was rapid during the year just closed. The natural course of development, combined with jitney competition, brought about innovations in street railway practice and threatens more. The rapid transit field saw the Municipal Railway service initiated in New York and the network of elevated and subways brought a long way nearer to completion. In interurban service noteworthy steps were taken in the adoption of high-tension direct currents. It is in the domain of steam-line electrification, however, that the most remarkable achievements have been scored. Early in the year, the completion of the Elkhorn project of the Norfolk and Western was a long stride toward general main-line electrification, while in the fall the inauguration of electric service over the Paoli division of the Pennsylvania into Philadelphia, accompanied by announcement of great progress made on the mountain divisions of the Chicago, Milwaukee and St. Paul, afforded a chance for interesting comparisons of a large eastern project with one in the west which is the most extensive yet attempted in this country.

The Philadelphia-Paoli electrification was undertaken primarily as a means of relief from terminal congestion and as the most economical method of increasing capacity. It applies thus far to suburban passenger traffic only. It was the first electrification undertaken by the Pennsylvania in the vicinity of Philadelphia and is particularly significant as indicating a further penetration of the electrification wedge into the mass of main-line steam operation. It is confidently expected that further suburban electrification will soon follow and it is reasonable to suppose that complete electrification of the Pennsylvania lines will gradually radiate from the great cities which they tap.

Traffic into the Broad Street station in Philadelphia had already passed the point of convenient capacity; gradual electrification was decided upon as quicker and cheaper than enlargement of the terminal. The Paoli section is only one of several which feed into this station, but it is believed that its electrification will operate to reduce the congestion by an amount equivalent to eliminating 8 per cent of the total number of trains. The station being of the stub-end type, much time was lost in switching locomotives and empty trains. The system of electrification adopted involves the use of motor-car trains without special locomotives, and this greatly facilitates switching besides making a somewhat shorter train. The relief obtained, it is estimated, will be sufficient for seven to eight years with a normal growth of traffic. The saving in operating costs should about pay interest on the additional investment. The advantages pertaining to all electrification from the point of view of the public are of course to be expected here, namely higher speed, smoother riding, increased punctuality and cleanliness.

The power used is an alternating current at 11,000 volts, single phase and 25 cycles. It is supplied to the trains from overhead catenary-suspended wires. The equipment extends for 20 miles from the Broad Street station. The standard support consists of two guyed tubular poles,

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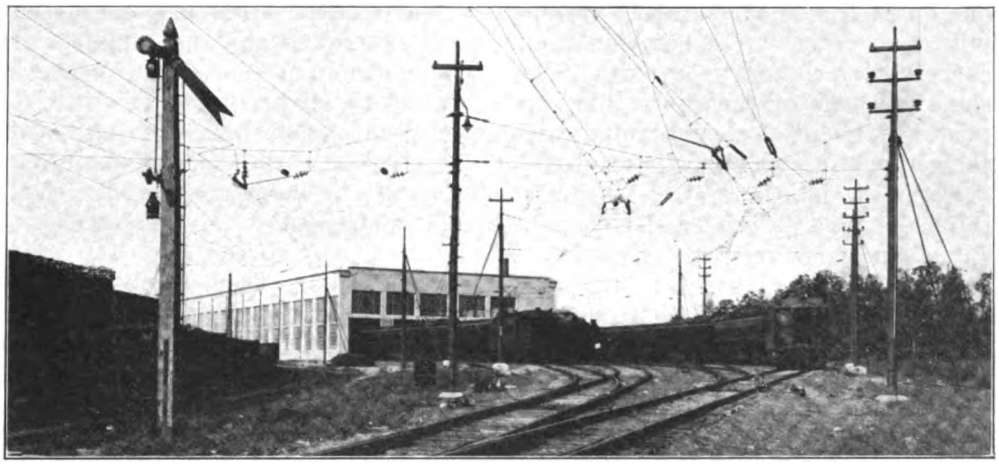
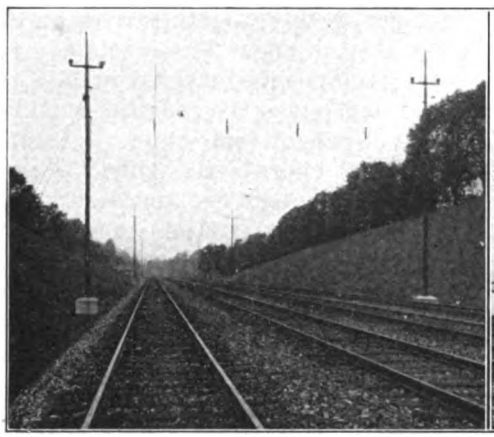
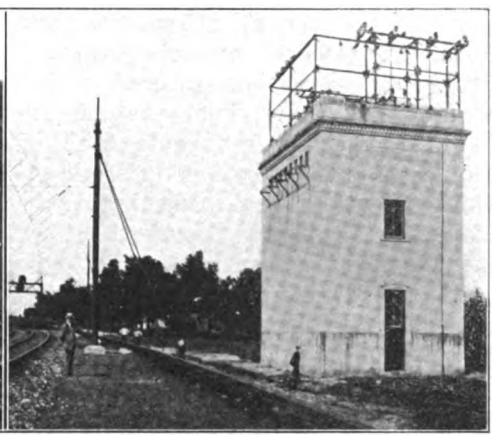


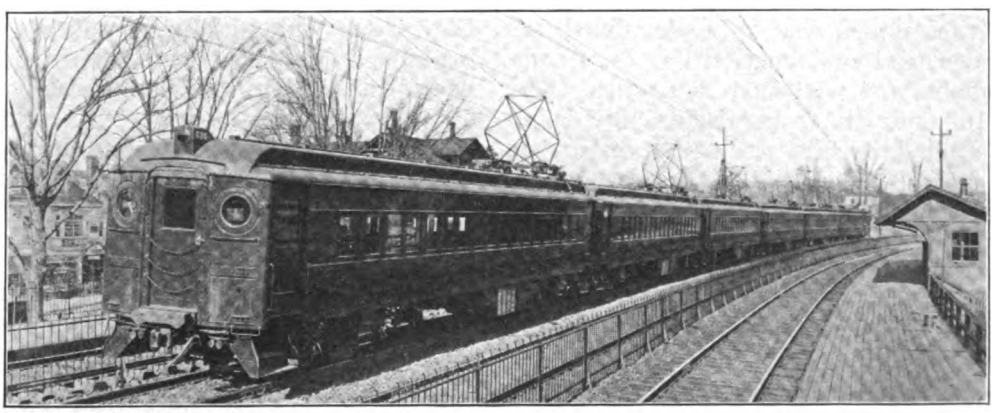
Car inspection building at Paoli.



Stretch of tangent-track construction.



Paoli substation



Typical multiple-unit train

VIEWS OF THE PAOLI ELECTRIFICATION OUT OF PHILADELPHIA

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one on each side of the track system, with two cross wires between them carrying the catenary supports. Over some portions of the route this support has had to be supplanted with self-supporting structural towers.

Standard suburban steel coaches of the same type as used in the regular suburban steam service are also used for the electrical service, provision having been made in their original design for possible installation of motor equipment. All the cars are motor cars; no trailers are to be used. Each car carries two 225-horsepower, single-phase motors. Current is collected from the wires by a pantagraph trolley.

In the Chicago, Milwaukee and Saint Paul work, entirely different problems were encountered. The traffic over the divisions which are being electrified is largely freight; mountain grades are encountered; the chief factor leading to electrification was power economy; locomotives, the most powerful ever built, are to be used; finally the transmitted alternating current is to be converted to direct current for the trolley system.

Construction work has been prosecuted actively since the initial order for equipment was placed with the General Electric Company in 1914, and now on the 650 miles of single track which was to be electrified, the overhead construction has been completed for well over 200 miles. The 100,000-volt transmission line being erected by the railway company to parallel the tracks has also been completed over about the same distance, and the tie-in lines from the Montana Power Company's system are ready for service. The trackage now available for train operation includes yards at three towns and passing tracks at other points. Rail bonding has been carried along after the wiring.

The trolley wires are carried by steel catenaries and the supports are wood poles in all cases both for brackets and for cross-spans. Twin wires are used except in switching yards and these have their points of support from the catenary staggered.

More than half the substations to supply power to the first 440 miles of route have been completed and electrical equipment is being rapidly installed. There are 14 such substations in all, and work is progressing rapidly on the remainder. In the substations, each motor-generator set consists of a 60-cycle, three-phase, 2300-volt synchronous motor direct connected to two 1500-volt direct-current generators, together with an exciter at each end. These sets are designed to operate inverted in case regenerated power exceeds the requirements of nearby trains and thus pump the excess energy back into the line. This eliminates the necessity for water boxes and other energy-consuming devices. It is interesting to note that a four-room and a five-room bungalow is being erected at each substation to house the families of the operators.

The greatest interest attaches to the giant locomotives. Of these, twelve are geared for passenger service and the other thirty for freight; they are all equipped for regenerative braking. Oil-fired steam boilers for heating the trains will be attached to all the passenger locomotives and to some of the freight. The first unit was shipped at the end of September and was exhibited by the railroad company at various stations along the route, to the astonishment of all beholders. The weight of a completed freight unit is 282 tons with 226 tons on the drivers. The locomotives are in two sections; current collection is through a pantagraph trolley installed on the front section.

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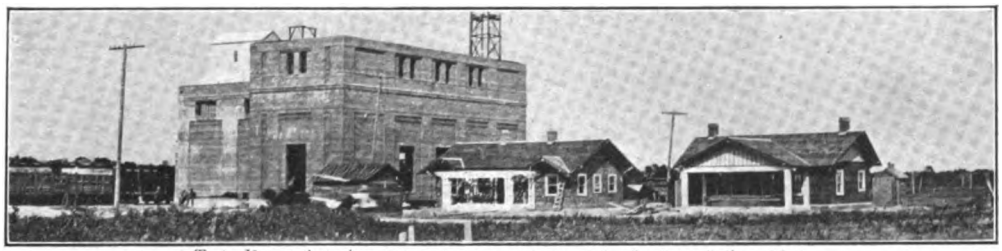
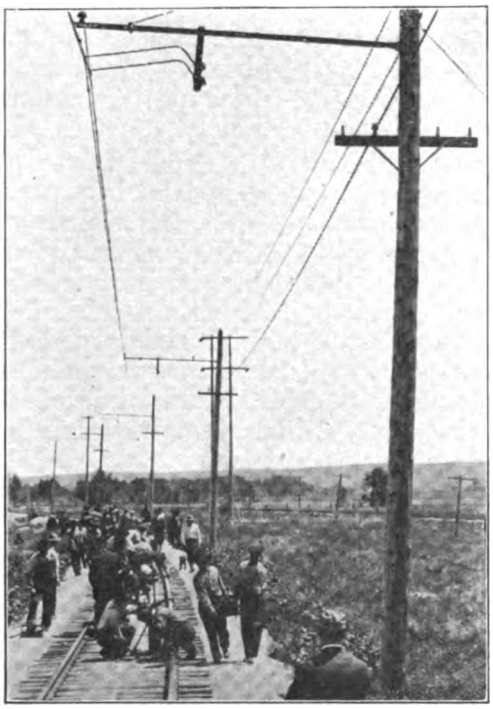
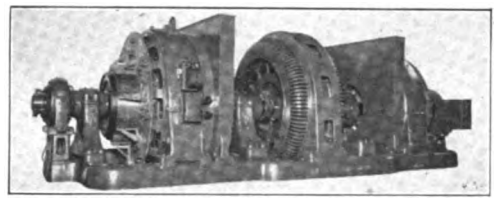


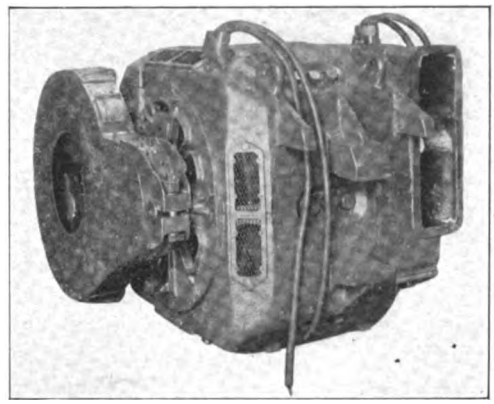
Two Dot substation, at extreme eastern end of electrified section



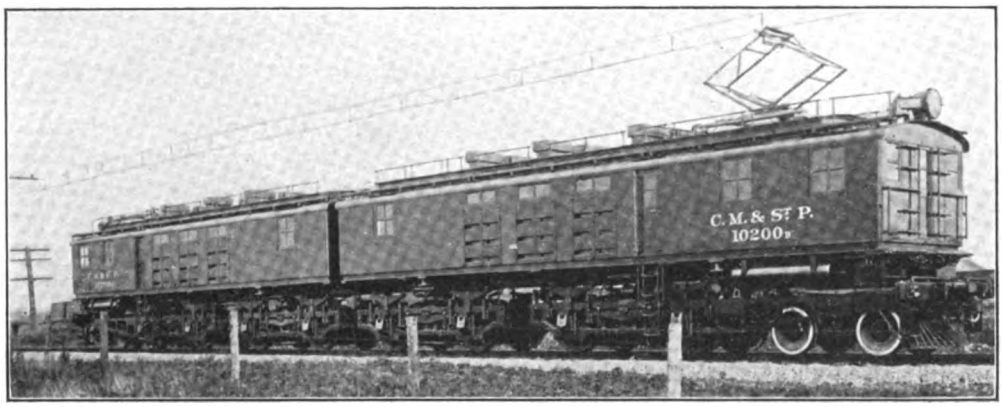
Bonding rails on a curve



Two-thousand-kilowatt motor-generator set, to deliver a 3000-volt, direct current to the trolley wires



One of the 430-horse power, 3000-volt motors for the locomotive shown below



One of the monster double electric locomotives
CHICAGO, MILWAUKEE & ST. PAUL WORK

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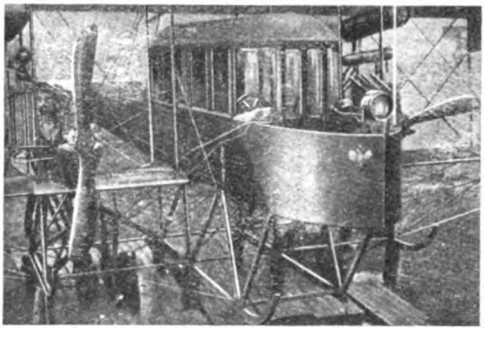
GIANT SIKORSKY AEROPLANE

RUSSIAN CRAFT OF GREAT CAPACITY AND RANGE

La Nature



RUSSIAN AIR MONSTER

THE progress of the war has seen astonishing development in the art of aviation. Reconnaisance aeroplanes of light weight and great speed but able to carry a maximum useful weight of only about 550 pounds have been supplemented by fighting craft, more powerful, heavier and slower, such as the Voisin and Farman biplanes. These aeroplanes can mount small guns up to 1½-inch caliber or can carry a number of heavy bombs. They have been used with good effect in bombarding towns and munition trains.

Constructors are constantly working to increase the speed and the carrying power of aeroplanes and have brought out double-motor, double-propeller machines which can lift 1,100 to 1,300 pounds. The success obtained with these has led to the expectation of building machines with four motors and propellers, veritable dreadnoughts of the air, superior even to Zeppelins.

This tendency toward larger machines was foreshadowed several years ago by the Russian Sikorsky, whose machine, Ilia Mouremetz, has rendered important services to the Russians. On February 25 of last year, he rose to a height of 1,600 feet with eight passengers and returned to his point of departure after a long journey. He then made another flight of six minutes with four additional passengers and his dog. Again he made a 16-minute flight with five more passengers, a total weight of almost a ton and a quarter. At present the machine can carry 20 passengers for 15 to 20 hours without landing, at a minimum speed of about 60 miles an hour.

The cabin and propellers of this aerial omnibus are shown in the illustration. Back of the front balcony is the pilot's dining room, now used as a munitions magazine. Back of this is a large cabin, lighted at night, in which 1½-in. guns are mounted; in addition there is a kitchen, a tiny closet and a place for the dynamo. The machine is driven by four Salmson motors of 500 horsepower. The spread surface of the planes is five times greater than that of any other aeroplane. The steel frame is 66 feet long. The machine has done serious military duty along the Galician front, in bombardment, photographing and fire control.

Greater speed will be developed in these gigantic aeroplanes and they bid fair to become a sort of police of the air. Every aviator believes that his art is passing through the same steps of development as water navigation has traversed and that eventually from fragile and unstable small-craft, great aerial vessels of many motors will be built which can bid defiance to wind and weather.

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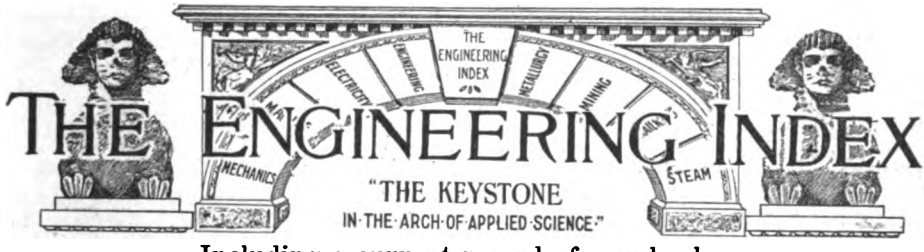

Including a current record of new books.

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

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CIVIL ENGINEERING

BRIDGES

Arches

Beitrag zur Bestimmung der Bogenform bei Wölbbrücken (65415 B). R. Doorentz. Ills. 2000 w. B u E—Oct. 4, 1915. Formulas for reinforced-concrete arches in bridges.

Bascule

Double-Deck Bascule Bridge Over Chicago River (65539). Hugh E. Young. Ills. 2700 w. Eng News—Nov. 4, 1915. Heavy double-leaf structure on Lake St.

Substructure of the Lake St. Bascule Bridge at Chicago (65689). Hugh E. Young. Ills. 2500 w. Eng News—Nov. 11, 1915. Foundations.

Building Code

Calcul et épreuves des ponts métalliques (65462 B). A. Goupil. Ills. 4000 w. Gen Civ—Oct. 23, 1915. New French regulations for design and testing of steel bridges.

Concrete

Architectural Effects Secured in Glens Falls Arch Bridge Over Hudson River (65570). Ills. 1200 w. Eng Rec—Nov. 6, 1915. Features of a reinforced-concrete arch of striking appearance.

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Design and Construction of a Reinforced Concrete Truss Bridge with Braced Counterfort. Abutments Near Merthyr, Wales (65823). Ills. Charles E. Holloway. 2000 w. Engng & Con—Nov. 17, 1915. Details.

Olympic Bridge, Island Park, Toronto (65998). E. M. Proctor. Ills. 900 w. Can Engr—Nov. 25, 1915. Artistic reinforced concrete arch.

Design

Street Bridges in Philadelphia Designed for Permanent Artistic Effects (65722). Ills. 2000 w. Eng Rec—Nov. 13, 1915. Steel protected by concrete with effective surface treatment.

Elevated Railroad

Full-Load Secondary Stresses in Elevated-Railway Bents (65690). L. R. Manville. Ills. 2200 w. Eng News—Nov. 11, 1915. Dangerous stresses and means of reducing them.

Hell Gate

Die Hell-Gate-Brücke über den East River in New York (65422 B). O. H. Ammann. Ills. 1800 w. Schw Bau—Oct. 16, 1915. General description.

Lift

Lift Spans Over Arkansas River Designed for Possible Shifting of Channel (66010). Ills. 3300 w. Eng Rec—Nov. 27, 1915. Unusual lifting mechanism used in bridge near Pine Bluff, Ark.

Design and Construction of the Substructure of the Buffalo River Lift Bridge, Buffalo, N. Y. (65645). Ills. 2500 w. Engng & Con—Nov. 10, 1915. Difficult construction of piers for lift span.

Portland, Me.

Construction Details of Bridge Across Portland Harbor (65536). Ills. 2500 w. Eng News—Nov. 4, 1915. Concreting methods; foundation work.

Quebec

Progress of Erection of the New Quebec Bridge (65670 A). Ills. & Plate. 1200 w. Engr, Lond—Oct. 29, 1915. Erection since April.

Railway

Hampton Court Junction Fly-over Line and Bridge, London & South-Western Railway (65913 A). Ills. 300 w. Ry Gaz, Lond—Nov. 12, 1915. Details of bridge.

Viaducts

St. Louis Municipal Bridge East Approach a Steel Viaduct Nearly 3 Miles Long (65874). Ills. 800 w. Eng Rec—Nov. 20, 1915. Details.

Fire Damage to Steel Viaduct and Method of Repair (65951). Ills. 900 w. Eng News—Nov. 25, 1915. Restoring Nickel Plate viaduct at Cleveland, O.

CONSTRUCTION

Acoustics

Acoustics of Auditoriums (65508 B). F. R. Watson. Ills. 1000 w. Br Build—Oct., 1915. Investigation of the armory of the University of Illinois.

Building Code

Building Area, Height and Other Limitations to Use of Private City Property Compiled (65721). Nelson P. Lewis. From a paper read at Engng. Cong. 2500 w. Eng Rec—Nov. 13, 1915. American and European practice.

Concrete

Die Eisenbetonbauten im Tiergarten in Nürnberg (65413 B). Hermann Goebel. Ills. 1500 w. B u E—Oct. 4, 1915. Buildings and other construction in reinforced concrete in Nuremburg Zoological Gardens.

Well-Designed Concrete Plant Aids Construction of Waterworks Dam (65724). Ills. 1800 w. Eng Rec—Nov. 13, 1915. Large capacity.

Concrete Buildings

Concrete Manufacturing Buildings in Hoboken, N. J. (65674 A). Charles Fall. Ills. 1000 w. Archt & Build—Oct., 1915. Group of buildings under construction.

Conduits

Sammelkanal in Eisenbeton von 200/250 cm Lichtweite (65414 B). W. Schwaab. Ills. 1200 w. B u E—Oct. 4, 1915. Design and construction of a reinforced concrete conduit.

Derricks

Long 15-Ton Guy Derrick Folds Into Compact Form (65332). Ills. 1000 w. Eng Rec—Oct. 30, 1915. Ball-and-socket umbrella hood replaces usual gudgeon pin.

Electrolysis

See STREET AND ELECTRIC RAILWAYS.

Excavation

Subaqueous Rock Excavation (65827). Charles C. Phelps. Ills. 3600 w. Eng News—Nov. 18, 1915. Serial, 1st part. Development of American practice. Use of drill barges for non-tidal waters.

The Brownhoist Shnable Drag-Line Bucket (65636 A). Ills. 700 w. Engng—Oct. 22, 1915. Manufactured in Cleveland, Ohio.

Floors

Concrete Floor Troubles (65860). Mac Rae D. Campbell. 1500 w. Ry Age Gaz—Nov. 19, 1915. Particularly requirements for railroad construction.

Foundations

Flachgründungen bei Wohnhausbauten in Budapest (65412 B). Hugo Szekely. Ills. 1500 w. B u E—Oct. 4, 1915. Design and construction of flat reinforced concrete foundations for apartment houses in Budapest.

Concrete Pile and Cylinder Foundations at Charleston (65687). Ills. 2000 w. Eng News—Nov. 11. 1915. Cylinders driven into clay with steam hammer; piles in cylinders.

Methods and Plant Used in Constructing the Foundations for the Field Museum of Natural History, Chicago, Ill. (65943). Ills. 2500 w. Engng & Con—Nov. 24. 1915. Layout of construction plant, with cost data.

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National Parks
See *Roads and Pavements.*

Oil Tank
Rebuilding a Burned Oil Tank (65828). C. P. Bowie. Ills. 1500 w. Eng News—Nov. 18, 1915. Methods adopted.

Patented Processes
See Patented Materials under *Materials of Construction.*

Reconstruction
Étude sur les constructions économiques (65446 D). E. Cacheux. 27 pp. Soc Ing Civ Fr Mem—April-June, 1915. Principles which should govern in rebuilding after war.

Terminals
Connecticut Shipping Terminal at New London (65949). W. E. Clarke. Ills. 3500 w. Eng News—Nov. 25, 1915. Analysis of alternative design as to economic life.

Design and Construction Features of the Ocean Steamship Co.'s Terminal at Savannah, Ga. (65502). Plan & Ills. 1500 w. Engng & Con—Nov. 3, 1915. Descriptive.

Tunnels
An Economic Comparison of European and American Methods of Driving Tunnel Heading (65944). Eugene Lauchli. 1800 w. Engng & Con—Nov. 24, 1915. Shows that no fair comparison can be made.

Modern Methods in Railway Tunnel Construction (65366). Charles S. Churchill. Ills. 5000 w. Ry Rev—Oct. 30, 1915. From paper at Int. Engng. Cong. Methods of excavating and lining.

The Astoria Tunnel Under the East River for Gas Distribution in New York City (66022 D). 4500 w. Am Soc Civ Engrs, Pro—Nov., 1915. Discussion of John Vipond Davies' paper.

East River Tunnel Shields (65691). Ills. 1900 w. Eng News—Nov. 11, 1915. Details of 18-ft. shields.

Construction Plant and Methods Employed in Concrete Lining a Double Track Railway Tunnel Under Traffic (65824). Rodman Meacham. Ills. 2000 w. Engng & Con—Nov. 17, 1915. Methods of construction the L. & N. Diana tunnel.

Completing the Mount Royal Tunnel into Montreal (65546). Map & Ills. 3500 w. Ry Age Gaz—Nov. 5, 1915. Details of construction.

Methods Used in Building the Rogers Pass Tunnel (65686). Ills. 3000 w. Eng News—Nov. 11, 1915. Pioneer-heading system. Details.

Construction Progress on the Twin Peaks Tunnel (65537). A. J. Cleary. Ills. 1200 w. Eng News—Nov. 4, 1915. Methods and progress on highway tunnel, San Francisco.

Underpinning
Soil Tests Reported and Safe Underpinning Methods in Sand Described (65873). Ills. 2000 w. Eng Rec—Nov. 20, 1915. Special precautions necessary in N. Y. Subway excavation.

Walkways
Inclined Walkways Replace Stairs and Elevators in New Victor Building at Camden (66006). Ills. 1200 w. Eng Rec—Nov. 27, 1915. Safety in exit.

IRRIGATION AND RECLAMATION

Arrowrock Dam
The Arrowrock Dam (65812 B). Charles H. Paul. Ills. 2500 w. Boston Soc of Civ Engrs, Jour—Nov., 1915. Preliminary work and construction.

Arrowrock Dam (65808). M. F. Cunningham. 1200 w. Wis Engr—Nov., 1915. Construction methods.

Ditch Excavation
Excavating Machinery Used in Land Drainage (65498 N). D. L. Yarnell. Ills. 39 pp. U S Dept Agri, Bul 300—Nov. 10, 1915. Construction, application and performance.

Pumping
Land Drainage by Means of Pumps (66011 N). Ills. 59 pp. U S Dept of Agri, Bul 304—Nov. 19, 1915. Design, construction and cost of levees, ditches and pumping plant.

Variable-Speed Pumping Plant for a Drainage District (64685). Ills. 600 w. Eng News—Nov. 11, 1915. Chain drive from different-sized sprockets.

Sudan
Irrigation in the Sudan (65639 A). 1400 w. Engr, Lond—Oct. 22, 1915. Recent progress and proposed schemes.

MATERIALS OF CONSTRUCTION

See also *Roads and Pavements.*

Aggregate
Screening and Washing Plants for Supplying Clean and Well Graded Aggregate (65733). Ills. 4000 w. Con-Cem Age—Nov., 1915. Describes successful plants.

Concrete
How Curing at Low Temperature Affects Concrete (65723). A. B. McDaniel. 1200 w. Eng Rec—Nov. 13, 1915. Reports results of tests.

Versuche zur Klarstellung der Wirkungsweise der Umschnürung bei Eisenbetonsäulen (65477 B). C. Bach. Ills. 1800 w. Z V d I—Oct. 30, 1915. Study of the efficiency of wrapped reinforcement in concrete columns.

Sand for Concrete and Cement Mortar Should Have "Jump" in Grading (66008). Robert H. McNeilly. Ills. 5000 w. Eng Rec—Nov. 27, 1915. New view, verified by tests.

Das Verhalten des Betons und Kunststeins gegen Geschosse (65440 B). P. Rohland. 1500 w. Gla Ann—Oct. 15, 1915. Experiments with concrete show its availability for military shields.

Iron Scale
Removing Iron Scale by Pickling; Theory vs. Practice (65521). Carl Hering. 1800 w. Met & Chem Engng—Nov. 1, 1915. Present method wrong in principle. Results with Reed electrolytic process.

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Paint

Paint (65524). G. B. Heckel. 6000 w. Address before Nat. Exp. of Chem. Ind. Met & Chem Engng—Nov. 1, 1915. Components and manufacture.

Patented Materials

How Shall Patented Materials or Processes in Public Works Be Handled? (65338). 4500 w. Eng Rec—Oct. 30, 1915. Daniel B. Luten discusses S. Whinery's article, and latter replies.

Piles

Experience with Protected Timber Piles in Tropical Waters, at San Juan, Porto Rico (65849 A). J. P. Carlin. Ills. 1500 w. Cornell Civ Engr—Nov., 1915. Causes of failure of cement-coated piles.

Pipe Joints

Joints for Wrought-Iron and Steel Pipe (65950). R. S. Lord. Ills. 2000 w. Eng News—Nov. 25, 1915. Development of present commercial types.

Timber

Timber in Canada (65553). R. H. Campbell. 2000 w. Can Engr—Nov. 4, 1915. From paper at Int. Engng. Cong. Outlines supply in each province.

Wire Rope

Wire Cables of Various Types and Materials Tested by U. S. Bureau of Standards (65565). Ills. 1200 w. Eng Rec—Nov. 6, 1915.

MEASUREMENT

Arches

The Design of Arches (65804 N). W. E. Lilly. 13 pp. Plate. Inst Civ Engrs of Ireland, Trans—Vol. XLI. Application of the catenary of uniform strength.

Some Notes on the Hydrostatic Curve and Its Application to the Theory of Stability of the Elliptic Masonry Arch (65801 N). J. T. Jackson. 23 pp. Inst Civ Engrs of Ireland, Trans—Vol. XLI. Theory and applications.

Asphalt

See *Roads and Pavements.*

Brick Testing

Spherical Bearings versus Flat Plates in Crushing Tests on Bricks (65763 A). E. L. Baker and Alex. F. Suss. A thesis. Ills. 1200 w. Assn Engng Socs, Jour—Oct., 1915. Tests and conclusions as to best method.

Cement Testing

Simple Cement Testing (65321). E. H. Bonnet. 1300 w. Coal Age—Oct. 30, 1915. Methods of procedure.

Columns

Note sur l'équation différentielle de la ligne neutre et de la fibre moyenne d'une pièce chargée de bout (65982 B). Aurel A. Beles. Ills. 1000 w. Gen Civ—Nov. 13, 1915. Mathematical considerations of the bending of loaded columns.

Concrete Testing

Testing Concrete and Aggregates—Laboratory and Field Methods (65734). R. E. Goodwin. Ills. 3000 w. Con-Cem Age—Nov., 1915. Methods of N. Y. Public Service Commission.

Eccentric Loading

Is a Part Stronger Than the Whole? (65948). R. Fleming. Diagrams. 1800 w. Eng News—Nov. 25, 1915. Material loaded eccentrically is in theory strengthened by cutting away one side; author dissents.

Floors

Tests Show How Loads Are Distributed on Reinforced-Concrete Slab Floors (65572). Ills. 3000 w. Eng Rec—Nov. 6, 1915. Effective width of slab determined.

Flow

Chemi-Hydrometry and Its Application to the Precise Testing of Hydro-Electric Generators (66017 D). Benjamin F. Groat. Ills. 325 pp. Am Soc Civ Engrs, Pro—Nov., 1915. Measurement of quantities of fluids by chemical methods; errors and their elimination, etc.

Frames

Calcul des cadres à angles considérés comme poutres continues (65421 B). E. Lacroix. Ills. 1200 w. Schw Bau—Oct. 9, 1915. Formulas for frames considered as continuous beams.

Hydraulic Jump

The Hydraulic Jump, in Open-Channel Flow at High Velocity (66025 D). Ills. 5500 w. Am Soc Civ Engrs, Pro—Nov., 1915. Discussion of Karl R. Kennison's paper.

Oil

See *Roads and Pavements.*

Rainfall

The Rain-Gauge in Rainfall Computations (65706). E. A. Lees. From a paper before Munic. W. Wks. Assn., London. 1400 w. Can Engr—Nov. 11, 1915. Methods.

Sea Level

Determinacion aproximada del nivel medio del mar y del plano de media marea baja (65495 A). Francisco Gaston. Ills. 7 pp. Soc Cub Ing Rev—Nov., 1919. Rules and tables for determining mean sea level and mean low tide in Cuba.

Structures

See Researches under MECHANICAL ENGINEERING, *Heating and Cooling.*

Surveying

Photographic Surveying (65805 N). M. T. Ormsby. Ills. 50 pp. Inst Civ Engrs of Ireland, Trans—Vol. XLI. General description of instruments and methods, not, however, including stereoscopic apparatus.

Topographical Railway Traversing (65554). J. A. MacDonald. 1200 w. Can Engr—Nov. 4, 1915. Use of the stadia.

Distribution of the Magnetic Declination in the United States for January 1, 1915, with Isogonic Chart and Secular Change Tables (65884 N). Daniel L. Hazard. 15 pp. U S Coast & Geod Surv—No. 33.

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A Direct-Reading Tacheometer (65802 N). H. H. Jeffcott. Plate. 40 pp. Inst Civ Engrs of Ireland, Trans—Vol. XLI. Account of an endeavor to improve tacheometric practice.

Some Points Generally Neglected in the Construction of Theodolites (65803 N). R. F. Waller. Plate. 21 pp. Inst Civ Engrs of Ireland, Trans—Vol. XLI. Improvements needed.

Trusses

Études sur les fermes métalliques sur poteaux (65447 D). Paul Guillot. Ills. 39 pp. Soc Ing Civ Fr Mem—April-June, 1915. Mathematical formulas for design of trusses on columns.

Wind Pressure

L'action du vent sur les constructions (65453 B). G. Espitallier. Ills. 2000 w. Gen Civ—Oct. 16, 1915. Serial, 1st part. Mathematics of wind pressures especially on hangars.

MUNICIPAL

Building Code

See Construction.

Economy

Municipal Economy in War-Time (65920 A). Edward Willis. 2000 w. Surveyor—Nov. 12, 1915. Serial, 1st part. Suggestions.

Refuse Destruction

Garbage Collection and Incineration in Sewickley, Pa. (65702). Edward E. Duff, Jr. Ills. 1500 w. Munic Jour—Nov. 11, 1915. Can collection.

Sanitation

A District Sanitary Disposal Plant (65517). Flora Spiegelburg. Ills. 1500 w. Sci Am Sup—Nov. 6, 1915. System for city waste.

Sewage Disposal

Marysville, Ohio, Sewage-Treatment Plant Provides for High Degree of Purification (65875). E. D. Barstow. 1200 w. Eng Rec—Nov. 20, 1915. Plan adopted.

Disposal of Greater New York's Sewage (65535). Charles E. Gregory. 2500 w. Munic Jour—Nov. 4, 1915. Abstract of paper before Munic. Engrs. of N. Y. General plan; digesting power of harbor.

New Sewage Disposal Works at Wanstead (65635 A). Ills. 4500 w. Engng—Oct. 22, 1915. Recent alterations and extensions.

Choosing Air Compressors for Activated-Sludge Tanks (65544). Carl H. Nordell. 2500 w. Eng News—Nov. 4, 1915. Types considered.

Sewerage

Keele Street Sewer System, Toronto (65878). Ills. 1500 w. Can Engr—Nov. 18, 1915. Serial, 1st part. Storm overflow sewer for western section.

Utility Lines

Comparative Merits of Four Types of Location of Underground Utility Lines (65506). Louis A. Dumond. From an article in *The American City*. 3000 w. Engng & Con—Nov. 3, 1915. Methods. European practice.

Chicago Builds Its First Utility Gallery (65719). Ills. 900 w. Eng Rec—Nov. 13, 1915. Details of construction.

Wastes

A Summary of the Experience Gained in the Treatment of the Wastes from the Scouring of Wool (65647). Harry R. Crohurst and Arthur D. Weston. 7000 w. Engng & Con—Nov. 10, 1915. Explains processes and wastes produced, and methods of disposal with results.

Test Plant Operated to Deodorize Oil Refinery Wastes (65335). F. R. Hesser. Ills. 1500 w. Eng Rec—Oct. 30, 1915. Aeration, coagulation, sedimentation, and storage tried at Neodesia, Kan.

ROADS AND PAVEMENTS

Asphalt

The Practical Testing of Asphalt and Road Oil (65646). T. A. Fitch. Read before Pan-Am. Road Cong. 2500 w. Engng & Con—Nov. 10, 1915. Brief explanation of methods.

Asphalt Repairing in Manhattan (65533). Ills. 1800 w. Munic Jour—Nov. 4, 1915. Method of using tractors economically.

Asphalt Plant

Operating Manhattan Asphalt Plant (65818). William Goldsmith. Abstract of part of paper before Munic. Engrs. of City of N. Y. Ills. 1500 w. Munic Jour—Nov. 18, 1915. Plant and its work.

Bituminous

Aggregates and Fillers for Bituminous Road Construction (65630 A). Plate. E. J. Lovegrove. 1000 w. Surveyor—Oct. 22, 1915. Need of careful selection and grading.

Brick

Some Brick Paving Lessons Learned in Overcoming Faults of Original Design, Greenville, Texas (65821). A. D. Duck. Abstract of paper before Am. Soc. of Munic. Imp. 2200 w. Engng & Con—Nov. 17, 1915. Details of work.

Concrete

A New and Different Specification for Concrete Roads (65822). Presented at meeting of Am. Soc. of Munic. Imp. 2500 w. Engng & Con—Nov. 17, 1915. For precise proportioning; worked out by W. W. Crosby.

Method of Constructing Concrete Road in Freezing Weather (65503). H. Colin Campbell. Ills. 1200 w. Engng & Con—Nov. 3, 1915. Precautions.

Pennsylvania Builds Concrete Road as Object Lesson (65331). Ills. Eng Rec—Oct. 30, 1915. Construction methods.

Crowning

Paving Crown Best Distributed by Hyperbolic Curve (65339). Clark R. Mandigo. 1500 w. Eng Rec—Oct. 30, 1915. New formula developed in Kansas City.

Granite

Notes on Methods and Costs of Grouting Granite Block Pavement (65504). 2000 w. Engng & Con—Nov. 3, 1915. Examples representing grouting practice.

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Gravel

Experiments with Gravel Roads in Iowa (66009). T. R. Agg. Ills. 2500 w. Eng Rec—Nov. 27, 1915. Details of construction.

Highways

Construction and Maintenance of Rural Highways (65666 A). Alfred Dryland. Read at Int. Engng. Cong. 2500 w. Surveyor—Oct. 29, 1915. English conditions.

Holland

Rijksstraatwegen (65411 B). T. Huitema. 2500 w. Ingenieur—Oct. 16, 1915. Brief account of government road construction and maintenance.

Hudson Valley

Alpine Roadbuilding in the Hudson River Valley (65947). Ills. 700 w. Eng News—Nov. 25, 1915. Roadbed on a mountain side carried by dry masonry retaining walls.

Johannesburg

Road Construction and Maintenance in Johannesburg (65631 A). G. S. Burt Andrews. From a paper before S. African Soc. of Civ. Engrs. 1700 w. Surveyor—Oct. 22, 1915. Serial, 1st part. Conditions and disadvantages.

Lime

The Use of Hydrated Lime in Concrete-Road Building (65621). L. N. Whitcraft. 1500 w. W Engng—Nov., 1915. Defects and remedies.

National Parks

United States Will Capitalize Its Scenery (65566). Ills. 1500 w. Eng Rec—Nov. 6, 1915. Development of national parks.

New York

Highway Work in New York (65534). From report of Henry W. Durham. Ills. 1500 w. Munic Jour—Nov. 4, 1915. Types of pavements for different streets.

Oil

Road Oil Test for Loss on Heating Needs Revision (65567). Norman Chivvis. 1600 w. Eng Rec—Nov. 6, 1915. Wide variation in evaporation due to convection currents in heating ovens.

Palisades

Making a Road Up the Palisades (65829). Ills. 1700 w. Eng News—Nov. 18, 1915. Brick-paved road to carry heavy traffic on an easy grade up steep slopes.

Repairs

Street Repair in Cleveland, Ohio (65618 A). Ills. 4000 w. Munic Engng—Nov., 1915. Methods and results.

Side Hill

Location and Grading of Side Hill Roads (65704). E. W. Murray. Read before Regina Engng. Soc. 2500 w. Can Engr—Nov. 11, 1915. Methods.

St. Louis

Test Results Will Form Basis for Selecting Pavements in St. Louis (65337). Nelson Cunliff. Ills. 1500 w. Eng Rec—Oct. 30, 1915. Experiments with types of surfacing.

WATER SUPPLY

Aqueducts

Curves on Winnipeg Aqueduct Built with Straight Sections of Forms (66007). Ills. 1500 w. Eng Rec—Nov. 27, 1915. Careful planning, method of laying out.

Canada

The Water Powers of Canada (65934 A). Editorial review. 2500 w. Engng—Nov. 12, 1915. Serial, 1st part. Water supply, distribution, development.

Canadian Hydraulic Power Problems (65879). 2000 w. From a paper by C. H. Mitchell read at Int. Engng. Cong. Can Engr—Nov. 18, 1915. Water storage and ice conditions.

Chemi-Hydrometry

See Flow under CIVIL ENGINEERING, *Measurement*.

Conduits

Pressure Test Shows Little Leakage from Huge Molded Concrete Pipe (65334). Ills. 1500 w. Eng Rec—Oct. 30, 1915. Baltimore test. Loss only one-third amount allowed.

Repairing a Submerged Water Main (65552). James Hamilton. Ills. 1000 w. Can Engr—Nov. 4, 1915. Edmonton water-supply; main in South Saskatchewan River.

Building Invert of Milwaukee Intake Tunnel (65543). Lee G. Warren. Ills. 900 w. Eng News—Nov. 4, 1915. Built after arch and side walls.

Dams

The Economical Top Width of Non-Overflow Dams (66018 D). 3000 w. Am Soc Civ Engrs, Pro—Nov., 1915. Investigation showing that it lies between 10 and 17 per cent of the height.

The Action of Water Under Dams (66020 D). W. R. Baldwin-Wiseman. 500 w. Am Soc Civ Engrs, Pro—Nov., 1915. Continued discussion of J. B. T. Colman's paper.

See also *Irrigation and Reclamation*.

Electrolysis

See Street and Electric Railways.

Fall River

Plan for Condensing-Water Supply for Fall River (65611). H. S. Knowlton. Ills. 1800 w. Power—Nov. 9, 1915. Four conduits in single structure.

Filtration

Multiple Filtration Plant at Accra, Gold Coast Colony (65780 A). Plate. 3000 w. Engng—Nov. 5, 1915. Multiple filters and raw water reservoir of reinforced concrete.

Toronto Filtration Plant Construction (66000). Ills. 1000 w. Can Engr—Nov. 25, 1915. New 60000000-gallon drifting sand filter plant.

Hamilton

Reconstruction of Hamilton, Ontario, Water Works (65617 A). Andrew F. Macallum. Read before Am. Soc. of Munic. Imp. Ills. 2500 w. Munic Engng—Nov., 1915. Difficulties and methods of overcoming them.

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Medicine Hat

Water Supply and Power at Medicine Hat (65313). Ills. 2000 w. Can Engr—Oct. 28, 1915. Municipal development comprising water supply and filtration and gas-generated electric power in one plant.

Montreal

Montreal Waterworks Situation (65705). Ills. 4000 w. Can Engr—Nov. 11, 1915. Outlines original scheme and extensions and power development under discussion.

Panama

Early Municipal Water Works at Panama (65832 B). Carleton E. Davis. (Abstract.) 2000 w. Fr Inst, Jour—Nov., 1915. Phases of the construction of the American work.

Philippines

The Location of Artesian Wells in the Philippine Islands from a Geologic Viewpoint (65835 N). Wallace E. Pratt. 2500 w. Philippine Jour of Sci—July, 1915. The relation of geologic formations to artesian supply.

San Francisco

Water Supply of the San Francisco-Oakland Metropolitan District (66019 D). 4500 w. Am Soc Civ Engrs, Pro—Nov., 1915. Continued discussion of H. T. Cory's paper.

Softening

Softening Plant Converts Hard, Impure River Water Into Boiler Feed Supply (65870). Ills. 2500 w. Eng Rec—Nov. 20, 1915. Installation at Youngstown, O., tube mill. Chemical treatment by intermittent system and rapid filtration.

Victoria

Sooke Lake Water Supply, Victoria, B. C. (65880). C. H. Rust. Ills. 2000 w. Can Engr—Nov. 18, 1915. Details of an extensive undertaking.

Ten and Three-Quarters Miles of 36-Inch Riveted-Steel Pressure Line Built on Sooke Work (65564). Boyd Ehle. Ills. 1200 w. Eng Rec—Nov. 6, 1915. Pipe line of Victoria, B. C.

WATERWAYS AND HARBORS

Barges

See MARINE AND NAVAL ENGINEERING.

Danube

La navigation sur le Danube (65983 B). Ch. Dantin. Ills. 3500 w. Gen Civ—Nov. 13, 1915. Political and commercial history of the Danube.

Flood Control

Progress Under the Conservancy Law of Ohio (65807 A). Kenneth C. Grant. 4500 w. Engrs' Soc of Penn, Jour—Oct., 1915. Flood legislation.

Galveston

Galveston Adopts Plan to Strengthen Its Waterfront Defense Against Future Storms (65571). Ills. 1000 w. Eng Rec—Nov. 6, 1915. Plan adopted.

International Waterways

The International Joint Commission (65314). Lawrence J. Burpee. Extract from article in *Univ. Mag.* 3800 w. Can Engr—Oct. 28, 1915. Questions relating to boundary waters between United States and Canada.

New Orleans

New Orleans Record for Succession of Storms Broken (65563). Map. 1500 w. Eng Rec—Nov. 6, 1915. Hurricane damage.

The Hurricane of Sept. 29th, 1915, and Subsequent Heavy Rainfalls (65436 N). Geo. G. Earl. Special report to Sewerage and Water Board of New Orleans.

Panama Canal

Goethals on Panama Slides (65945). Ills. Also editorial. 4800 w. Eng News—Nov. 25, 1915. Report of George W. Goethals to the Sec. of War.

Ten Million Yards of Material Must Be Removed to Stop Panama Canal Slides (66005). Ills. 4000 w. Eng Rec—Nov. 27, 1915.

Philadelphia

Modern Port Improvements in Philadelphia (65527 A). John Meigs. 8000 w. Jour Am Soc of Marine Draftsmen—Oct., 1915. Present situation and plans for development.

Port Facilities

Port Facilities and View on Expansion (65672). Edward F. McSweeney. Address at convention of Atlantic Deeper Waterways Assn. 3500 w. Mfrs' Rec—Nov. 11, 1915. Conditions in America; need of merchant marine; difficulties.

River Control

High Levees Will Protect Indianapolis from Floods (65562). Ills. 2500 w. Eng Rec—Nov. 6, 1915. Barrier of earth and concrete; construction methods.

Indianapolis Flood Protection (65825). Ills. 3000 w. Eng News—Nov. 18, 1915.

Rock Excavation

See Excavation under *Construction.*

San Francisco

The Waterway at the Mare Island Navy Yard (65619). M. H. Peck. Ills. 5800 w. W Engng—Nov., 1915. Deep-water channel, easily maintained.

South America

Conditions on the West Coast of South America (65850 A). A. B. Lueder. Ills. 2500 w. Cornell Civ Engr—Nov., 1915. Coasts and harbors; need of improvements.

Venice

Port Channels of Venice Kept Clear by Tidal Movement Properly Controlled (65876). 1800 w. Eng Rec—Nov. 20, 1915. Prof. Luigi Luiggi describes effective jetties. Suggestions applicable to all estuaries.

Welland Canal

Progress on the New Welland Ship Canal (65703). Ills. 1600 w. Can Engr—Nov. 11, 1915. Reviews construction work during past year.

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MISCELLANY

Military Engineering

Specialized Experience of Engineers and Contractors Vital to Country's Defense (65720). George Perrine. Ills. 1500 w. Eng Rec—Nov. 13, 1915.

Sugar Plantation

Engineer of Modern Sugar Plantation Has to Deal with Varied Problems (65333). Samuel Vickess. Ills. 2500 w. Eng Rec—Oct. 30, 1915. Plant of Niquero Co. in Cuba.

ELECTRICAL ENGINEERING

COMMUNICATION

Cables

Untersuchungen an Telephonkabeln (65403 B). Ernst Felix Petritsch. Ills. 3500 w. E u M—Sept. 12, 1915. Serial, 1st part. Study of characteristics of telephone cables.

Radio-telegraphy

Note on the Resistance of Radiotelegraphic Antennas (65964 N). L. W. Austin. 500 w. U. S. Bureau of Stand, Sci paper 257—Oct. 16, 1915. Study of rise of antenna resistance curve.

Radio-telephony

Latest Steps in Wireless Telephony (65989 A). Harold Pender. Ills. 4000 w. Engng Mag—Dec., 1915. Technical aspects of recent long-distance telephony.

Transatlantic Wireless Telephony Accomplished (65362). John J. Carty. 1500 w. Telephony—Oct. 30, 1915. Between Arlington and Paris.

Ein neues System für drahtlose Telephonie (65978 B). August Hund. Ills. 3000 w. E u M—Oct. 31, 1915. New device, the "Pleiotron," for facilitating wireless speech.

Telephony

Superimposed or "Phantom" Telephone Circuits (65629 A). Ills. 2200 w. Elect'n, Lond—Oct. 22, 1915. Serial, 1st part. Advantages and economies.

Improvement of Long Distance Telephone Transmission (65578). C. J. Larson. Report to E. Penn. Ind. Tel. Assn. 2000 w. Telephony—Nov. 6, 1915. Suggestions.

The Study of Transmission Problems by Means of Vectors (65360). E. W. Kellogg. Diagrams. 2500 w. Telephony —Oct. 30, 1915. Method and application.

ELECTRO-CHEMISTRY

Electrolysis

Motion Pictures of Electrolysis (65960). Ills. 500 w. Sci Am Sup—Nov. 27, 1915. Their aid in scientific investigation.

Nitrogen Fixation

Fixation of Atmospheric Nitrogen (65895 D). 2500 w. Am Inst of Elec Engrs, Pro—Nov., 1915. Discussion at New York, March 12, 1915, of Leland L. Summers' paper.

Primary Cells

Some Suggestions as to the Proper Care of Dry Cells (65576). W. W. Kinsley, Jr. Ills. 1000 w. Telephony—Nov. 6, 1915. Handling, storing, and testing.

Potassium Photo-Electric Cells (65961). Herbert E. Ives. Ills. 4000 w. Sci Am Sup—Nov. 27, 1915. Serial, 1st part. Study of the relationship of illumination and current.

ELECTRO-PHYSICS

Arcs

Unstable States in Arc and Glow (65742 A). W. G. Cady. Read before Am. Elec.-Chem. Soc. 3500 w. Met & Chem Engng—Nov., 1915. Phenomena showing unstable nature of some forms of gas discharge, with conclusions.

Conductors

Effective Resistance and Inductance of Iron and Bimetallic Wires (65972 N). John M. Miller. 60 pp. U S Bureau of Stand—Nov. 8, 1915. Theoretical and experimental investigations. Formula.

Contact Electrification

Contact Electrification and the Electric Current (65650 A). Fernando Sanford. 3500 w. Sci M—Nov., 1915. Early experiments and theories.

Corona

Comparison of Calculated and Measured Corona Loss Curves (65891 D). 700 w. Am Inst Elec Engrs, Pro—Nov., 1915. Discussion at New York, Feb. 17, 1915, of the paper by F. W. Peek, Jr.

Electromagnets

Solenoid and Electromagnetic Windings (65889 D). George L. Hedges. 20 pp. Am Inst Elec Engrs, Pro—Nov., 1915. Design is discussed.

Emissivity

The Emissivity of Metals and Oxides. IV. Iron Oxides (65969 N). George K. Burgess and Paul D. Foote. 1500 w. U S Bureau of Stand—Oct. 28, 1915. Experimental investigation.

Heating

The Temperature of Field Windings (65712). H. M. Phillips. 1800 w. Elec Rev & W Elect'n—Nov. 13, 1915. Electrical construction.

Induction

Some Problems of Electromagnetic Induction (65774 A). G. W. O. Howe. Ills. 3000 w. Elect'n, Lond—Nov. 5, 1915. Studies of induction.

Insulation

Electrical Characteristics of Solid Insulations (65355 A). F. W. Peek, Jr. 3000 w. Gen Elec Rev—Nov., 1915. Laws of breakdown, etc.

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Magnetism

Temperature Coefficient of Magnetic Permeability Within the Working Range (65965 N). R. L. Sanford. 1500 w. U S Bureau of Stand—Oct. 28, 1915. Work undertaken to determine the magnitude of this temperature effect.

Oscillations

Production of Undamped Electric Oscillations by Quenched Spark Dischargers (65917 A). Hidetaugu Yagi. Ills. 1000 w. Elect'n, Lond—Nov. 12, 1915. How they may be obtained.

Rays

Sobre los rayos producidos por los rayos Röntgen (65485 N). J. Laub. Ills. 24 pp. Soc Cien Arg An—May-June, 1915. Studies of rays developed by incident X rays.

Research

Recent Researches in Electricity at the Bureau of Standards (65831 B). E. B. Rosa. Ills. 7500 w. Fr Inst, Jour—Nov., 1915. Survey of current research work of the electrical division.

Terrestrial Magnetism

Results of Magnetic Observations Made by the United States Coast and Geodetic Survey in 1914 (65885 N). Daniel L. Hazard. 65 pp. U S Coast & Geod Surv ——No. 25. Observations, corrections, tables, and descriptions of stations.

Waves

La propagation des ondes électriques a la surface de la terre at la couche ionisée de l'atmosphère (65492 B). H. Nagaoka. 3500 w. Rv Gn Sc—Oct. 30, 1915. Analysis of certain phenomena encountered in radio-communication.

GENERATING STATIONS

Accumulators

The Use of Accumulators in Alternate-Current Stations (65628 A). L. Schroder. Abstract from *Elektro Zeit.* Diagrams. 2000 w. Elect'n, Lond—Oct. 22, 1915. Experiments to test uses.

Alabama

The Future of Water-Power Development in Alabama (65589). Thomas W. Martin. Read before Ala. Lgt. & Trac. Assn. 2500 w. Elec Rev & W Elect'n—Nov. 6, 1915. Shows new uses and new markets for electrical energy.

Auxiliary Plants

Auxiliary Steam Power Plant for Vancouver Island (65609). W. L. Kidston. Ills. 2500 w. Power—Nov. 9, 1915. Put in service one-half hour after completion.

Central Plants

Cumberland Edison Power Plant (65907). Warren O. Rogers. Ills. 3000 w. Power—Nov. 23, 1915. Equipment arranged on unit basis.

Combination Plants

Combination Electric Heating Plant, Laramie, Wyo. (65374). A. E. Anderson. Ills. 3000 w. Power—Nov. 2, 1915. Supplies electric current and district heating.

Current Selling

The Sale of Current to Municipally Owned Distributing Systems by Central Stations (65711). W. Rawson Collier. From a paper before N. E. L. A. 2500 w. Elec Rev & W Elect'n—Nov. 13, 1915. A study.

Hydro-Electric

The Lake Spaulding Hydroelectric Development of the Pacific Gas & Electric Co. (65692 A). R. L. Dougherty. Ills. 1500 w. Sib Jour of Engng—Nov., 1915. Detailed description.

Combination Steam and Water Plant (65730). Ills. 1800 w. Prac Engr, Chicago—Nov. 15, 1915. Small plant at Terryville, Conn.

A Hydroelectric Plant on the Savannah River (65864). Ills. 1200 w. Elec Wld —Nov. 20, 1915. A 13000-kva. plant connected with a steam generating station, and a 44000-volt transmission line.

Isolated Plant

Isolated Power-House for Factories (65356 A). W. E. Francis. Ills. 5000 w. Gen Elec Rev—Nov., 1915. Information to apply in design, construction, and operation.

London

New Plant at the Stepney Electricity Works (65640 A). Ills. 3500 w. Engr, Lond—Oct. 22, 1915. Improvements and extensions at this London station.

Meters

La tarification de l'électricité (65493 B). Ernest Coustet. Ills. 3000 w. Rv Gn Sc—Oct. 30, 1915. Methods of selling electricity and instruments therefor.

Moscow

La station centrale d'électricité (65494 B). J. Vichniak. Ills. 2500 w. Gn Cv —Nov. 6, 1915. General description of central station in Moscow.

Private Plants

A Private Electrical Plant at Kensington (65788 A). Ills. 1800 w. Engr, Lond—Nov. 5, 1915. Example of modern private installation.

Rates

The Multiplex Cost and Rate System (65896 D). 1600 w. Am Inst Elec Engrs, Pro—Nov., 1915. Discussion at Portland, Ore., Jan. 5, 1915, of Otto B. Goldman's paper.

Reconstruction

Building a Power Station Upon One in Service (65325). Ills. 1500 w. Elec Wld—Oct. 30, 1915. Serial, 1st part. Work at Springfield, O. Station arranged for efficient operation.

Shanghai

Shanghai Electricity Works (65772 A). Ills. 1600 w. Elec Rev, Lond—Nov. 5, 1915. Serial, 1st part. Detailed description.

Short-Circuits

Mechanical Effects of Electrical Short-Circuits (65357 A). S. H. Weaver. 2500 w. Gen Elec Rev—Nov., 1915. Determining the stress.

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Substations

The Development and Operation of Outdoor Substations (65588). F. L. Hunt. Read before Nat. Assn. of Elec. Insp. 3000 w. Elec Rev & W Elect'n—Nov. 6, 1915. Serial, 1st part. Progress and advantages.

Substation to Serve New York Theater District (65556). Ills. 2500 w. Elec Wld—Nov. 6, 1915. To economize in copper and duct construction.

Switchboards

Electrically - Operated Switchboards (65347). H. A. Travers. Ills. 4000 w. Elec Jour—Nov., 1915. Component parts of the control equipment.

GENERATORS AND MOTORS

Commutators

Berechnung und Bauart von Kommutatoren für hohe Geschwindigkeiten (65443 B). Ills. 1800 w. Ply Rnd—Oct. 17, 1915. Method of calculating and building commutators for high-speed machines.

Controllers

Alternating-Current Controllers for Steel Mills (Simon); The Alternating Current Coal Hoist (Brown) (65903 D). 20 pp. Am Inst Elec Engrs, Pro—Nov., 1915. Two papers discussed together at Pittsburgh, Pa., April 16, 1915.

Mill Controllers (Stratton), and Steel Mill Controllers from the Operator's Standpoint (Riggs) (65902 D). 26 pp. Am Inst Elec Engrs, Pro—Nov., 1915. Two papers discussed together at Pittsburgh, Pa., April 15, 1915.

Power Factor

Synchronous Motors for Power-Factor Corrections (65866). Th. Schou. Curves. 3000 w. Elec Wld—Nov. 20, 1915. Effects of low power-factor, and benefits of synchronous condensers and motors.

Small Motors

Fractional Horse Power Motor Load (65894 D). 1000 w. Am Inst Elec Engrs, Pro—Nov., 1915. Discussion at Cleveland, Ohio, March 19, 1915, of Bernard Lester's paper.

Torque

Torque Characteristics of Direct-Current Motors (66038). Alan M. Bennett. Ills. 3800 w. Power—Nov. 30, 1915. What the torque of a motor is, how it is determined, and how it varies in shunt, compound, and series motors.

ILLUMINATION

Animal Light

The Production of Light by Animals (65830 B). Ulric Dahlgren. Ills. 8500 w. Fr Inst, Jour—Nov., 1915. Serial, 1st part. A study of the light producing power and the principles governing the process.

Gas-Filled Lamps

Half-Watt Lamps from the Central Station Standpoint (65773 A). Elec Rev, Lond—Nov. 5, 1915. Advantages and economy.

Illuminating Engineering

Some Factors in Illuminating Engineering (65693 A). F. K. Richtmyer. 2500 w. Sib Jour of Engng—Nov., 1915. Serial, 1st part. First of a series of articles discusses the development.

Incandescent Lamps

Vergleichende photometrische Untersuchungen an Glühlampen (65405 B). K. Zickler. Ills. 3000 w. E u M—Sept. 26, 1915. Serial, 1st part. Photometric investigation of relative efficiency of certain types of incandescent lamps.

Lighting Code

A Code for Better Industrial Lighting (65865). C. E. Clewell. Ills. 2200 w. Elec Wld—Nov. 20, 1915. Review of the Code of Lighting recently issued by the Illuminating Engineering Society.

Residences

The Illumination of the Suburban Home (65507 B). Harold L. Alt. Ills. 4000 w. Br Build—Oct., 1915. Electricity or acetylene.

Schools

School Room Lighting (65673 A). F. Laurent Godinez. Ills. 1200 w. Archt & Build—Oct., 1915. Serial, 1st part. Causes of eye disturbance.

Stairways

Das Breslauer System der elektrischen Treppenbeleuchtungen (65406 B). Arthur v. Alkier. Ills. 2500 w. E u M—Oct. 3, 1915. Details of method adopted for staircase lighting in Breslau.

Streets

Parallel vs. Staggered Arrangement of Lamps (65557). H. E. Butler. Ills. 600 w. Elec Wld—Nov. 6, 1915. Merits of the two systems.

MEASUREMENT

Alternating Current

Ueber Wechselstrommessungen (65441 B). Richard Hiecke. Ills. 3500 w. E u M—Oct. 17, 1915. Certain features in the measurement of alternating currents.

Alternating-Current Ammeters and Voltmeters (65664 A). Ills. 4000 w. Elect'n, Lond—Oct. 29, 1915. Types, tests, and features of different instruments.

Chemi-Hydrometry

See Flow under CIVIL ENGINEERING, *Measurement.*

Curves

Graphic Method for Speed-Time and Distance-Time Curves (65889 D). 42 pp. Am Inst Elec Engrs, Pro—Nov., 1915. Discussion at New York, Nov. 13, 1914, of E. C. Woodruff's paper.

Electric Furnaces

Heat Losses from an Electric Furnace (65381 A). W. H. Wills and A. H. Schuyler. 1800 w. Ir Age—Nov. 4, 1915. Experimental investigations.

Illumination

Short Cuts in Calculations for Lighting Systems (65615). Robert Ffrench Pierce. 2500 w. Am Gas Lgt Jour—Nov. 8, 1915. Charts and their use.

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A Direct-Reading Device for Use in Computing Characteristics of Vacuum Tungsten Lamps (with Computing Chart) (65973 N). J. F. Skogland. 20 pp. U S Bureau of Stand—Nov. 8, 1915. The device and its use.

Inductance

Methods of Measuring the Inductances of Low-Resistance Standards (65966 N). Frank Wenner, Ernest Weibel, and F. B. Silsbee. 2500 w. U S Bureau of Stand—Oct. 28, 1915. Two methods for determining the phase angles of low-resistance standards without recourse to computed values.

Insulators

Electrical Porcelain (65892 D). 24 pp. Am Inst Elec Engrs, Pro—Nov., 1915. Discussion at New York, Feb. 19, 1915, of E. E. F. Creighton's paper.

Recording Meters

Classification, Construction, and Application of Graphic Recording Meters (65345). A. E. Allen. Ills. 3000 w. Elec Jour—Nov., 1915. Usefulness of graphic meter records.

Winding

Ueber einphasige Spulenwicklungen mit ungleicher Drahtzahl pro Nut (65475 B). K. Sachs. Ills. 2000 w. E u M—Oct. 24, 1915. Serial, 1st part. Mathematical development of principles of coil winding with varying numbers of wires to the slot.

POWER APPLICATIONS

Canada

Electric Power in Canadian Industry (65916 A). Charles H. Mitchell. Abstract of paper before the Int. Engng. Cong. 4000 w. Elect'n, Lond—Nov. 12, 1915. Study of the use and distribution.

Domestic Uses

Domestic Uses of Electricity Around Boston (65326). Ills. 1500 w. Elec Wld—Oct. 30, 1915. Cooking, heating, refrigeration, and other applications.

Elevators

Wait Turbo-Generator on Elevator Load (65910). Ills. 1800 w. Power—Nov. 23, 1915. Specially designed to carry six elevators and numerous tungsten lamps simultaneously.

Flour Mills

Electric Drive in Flour Mills and Similar Industries (65346). T. E. Simpers. Ills. 2500 w. Elec Jour—Nov., 1915. Type and characteristics of motor required.

Haulage

Centrally Controlled Electric Haulage Systems (65749 B). F. E. Woodford. Also discussion. Ills. 7000 w. Engrs' Soc of W Penn, Pro—Oct., 1915. General description.

Heating

La crisi del carbone ed il riscaldamento elettrico (65427 B). Elvio Soleri. 1500 w. Indus—Oct. 10, 1915. Field for electrical heating in Italy in view of high coal prices.

Implement Manufacture

Electricity in Harvesting Machine Works (65710). Ills. 3300 w. Elec Rev & W Elect'n—Nov. 13, 1915. The plant of the International Harvester Works.

Marble Plants

Electrical Equipment of the Vermont Marble Company (65353 A). John Liston. Ills. 3500 w. Gen Elec Rev—Nov., 1915. Outlines the operating conditions.

Motor Applications

Factors Involved in Motor Application (65897 D). 80 pp. Am Inst Elec Engrs, Pro—Nov., 1915. Discussion at Cleveland, O., March 19, 1915. of David B. Rushmore's paper.

The Characteristics of Electric Motors Involved in Their Application (65898 D). Ills. 56 pp. Am Inst Elec Engrs, Pro—Nov., 1915. Discussion at New York, Feb. 17, 1915, of David B. Rushmore's paper.

Precipitation

Electrical Precipitation—Theory of the Removal of Suspended Matters from Fluids, (Strong); Electrical Precipitation, (Nesbit); and Practical Application of Electrical Precipitation, (Bradley) (65893 D). 3000 w. Am Inst Elec Engrs, Pro—Nov., 1915. Three papers discussed together at New York, Feb. 19, 1915.

Quarrying

Electricity in Marble Quarrying (66028). Ills. 2000 w. Elec Rev & W Elect'n—Nov. 27, 1915. Installation of the Vermont Marble Co.

Steel Mills

Electrical Practice in Steel Mills (65681). D. M. Petty, From a paper read at Detroit, before the Assn. of Iron & Steel Elec. Engrs. 1500 w. Ir Trd Rev—Nov. 11, 1915. Electrical equipment and its advantages.

Textile Mills

Electricity in Textile Mills (65323). H. A. Orr. From a paper before Nat. Elec. Lgt. Assn. Ills. 1500 w. Elec Rev & W Elect'n—Oct. 30, 1915. Arguments in favor of purchasing power.

TRANSFORMERS

Losses

Eine neue Art zusätzlicher Verluste im Transformatorenkupfer (65404 B). M. Vidmar. Ills. 3500 w. E u M—Sept. 19, 1915. Explanation and quantitative investigation of a new sort of copper loss in transformers.

Manhole Apparatus

Manhole Transformers for Underground Alternating-Current Distribution (65348). E. G. Reed. Ills. 1200 w. Elec Jour—Nov., 1915. Analysis.

TRANSMISSION AND DISTRIBUTION

Cables

The Effect of Moisture in the Earth on Temperature of Underground Cables (65890 D). 2200 w. Am Inst Elec Engrs. Pro—Nov., 1915. Discussion of New York, Feb. 17, 1915, of L. E. Imlay's paper.

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Notes on Faults in Cables (65627 A). E. P. Austin. 1000 w. Elec Rev, Lond—Oct. 22, 1915. Investigates causes of inaccurate location tests.

Conductors

Size of Electrical Conductors (65396). H. M. Phillips. 2000 w. Natl Engr—Nov., 1915. Serial, 1st part. First considerations. Factors of safety.

Faults

Locating Faults by the Drop-of-Potential Method (66029). H. S. Percival. 3000 w. Elec Rev & W Elect'n—Nov. 27, 1915. Theory and applications.

Georgia-Carolina

Georgia-Carolina Company Transmission System (66002). Ills. 1500 w. Elec Wld—Nov. 27, 1915. Line, river-crossing structures; substation.

Insulators

Insulator Performance from Operating Viewpoint (65713). E. P. Peck. Ills. 2000 w. Elec Wld—Nov. 13, 1915. Insulator troubles and tests.

The Construction of Insulators Out of "Hard Paper" or "Pertinax" (65918 A). K. Fischer. Abstract from *Elektro. Zeit.* Ills. 2000 w. Elect'n, Lond—Nov. 12, 1915. A study of the most suitable shapes.

Line Disturbance

Line Disturbances Caused by Special Squirrel-Cage and Wound-Rotor Motors when Starting Elevators and Hoists (65900 D). 1500 w. Am Inst Elec Engrs, Pro—Nov., 1915. Discussion at Cleveland, Ohio, March 18, 1915, of J. C. Lincoln's paper.

Reactors

The Use of Current-Limiting Reactors (65813 D). W. M. Dann and H. H. Rudd. Ills. 2200 w. Ohio Soc Mech, Elec, & Steam Engrs, Jour—Vol. VIII. No. 1. Advantages.

Short Circuits

Theoretical Investigation of Electric Transmission Systems under Short Circuit Conditions (65901 D). 6500 w. Am Inst Elec Engrs, Pro—Nov., 1915. Discussion at New York, Jan. 8, 1915, of I. W. Gross' paper.

Thury System

The Thury System of Direct Current Transmission (65354 A). William Baum. Ills. 6000 w. Gen Elec Rev—Nov., 1915. Describes system and discusses advantages and disadvantages.

Z Connection

Advantages of the Z Connection (65349). Alfred J. A. Peterson. Diagrams. 2000 w. Elec Jour—Nov., 1915. Use in protective circuits.

INDUSTRIAL ECONOMY

EDUCATION

Applied Science

Technical Education for the Professions of Applied Science (65798 A). 5500 w. Worcester Poly Inst, Jour—Nov., 1915. Read at Int. Engng. Cong. Relates to the professional side of applied science.

Central-Station Training

Training Men for the Central Station Industry (65324). Ills. 2000 w. Elec Wld—Oct. 30, 1915. Serial, 1st part. Commonwealth Co. of Chicago.

Engineers

The Engineer of the Future and His Education (66013 A). John R. Allen. Also discussion. 8000 w. Cleveland Engng Soc, Jour—Nov., 1915. Need of broad education.

India

Technical Training in India (65787 A). 3300 w. Engr, Lond—Nov. 5, 1915. Critical discussion of methods.

Industrial Education

Education and Industrial Efficiency (65482 N). H. L. Gantt. 7 pp. Amer Econ Assoc. Discussion of paper by Edward D. Jones.

Machine Design

Machine Design in a Rhode Island School (65677 A). W. E. Freeland. Ills. 1200 w. Ir Age—Nov. 11, 1915. Instruction at the R. I. School of Design.

Railway Work

Education for Railway Work (65709). Samuel O. Dunn. 3000 w. Ry Age Gaz—Nov. 12, 1915. Address at opening of Commerce School of Northwestern University, Chicago.

South America

Education in Central and South America (65435). 8 pp. Nat Assoc Corp Schools Bull—Nov., 1915. Review of present situation.

FINANCE AND COSTS

Accounting

Navy Yard Accounting (65481 N). G. P. Auld. 21 pp. U S Naval Inst Pro—Sept.-Oct., 1915. Methods of keeping costs.

Cost Keeping

Depreciation, Interest, and Manufacturing Cost (65660 A). Walter C. Wright. 1200 w. Jour of Acc—Nov., 1915. Brief discussion of the question.

Uniform Cost Systems (65736). William M. Kennedy. 2500 w. Boiler Maker—Nov., 1915. Where and how the direct labor percentage plan fails.

Depreciation

Some Factors to be Considered in Fixing Depreciation (65577). E. C. Hurd. Address before Nat. Ind. Tel. Assn. 3000 w. Telephony—Nov. 6, 1915. Ascertaining probable life of a telephone property.

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Expense Distribution

Overhead Distribution by the Machine Unit System (65991 A). N. T. Ficker. Ills. 4500 w. Engng Mag—Dec., 1915. Seventh article in series, taking up characteristics of unit system.

Foundry Costs

Wertberechnung in der Giesserei (65483 B). J. and L. Treuheit. Ills. 4000 w. St u E—Oct. 28, 1915. Interesting formulas and tables for calculating financial results in foundry operation.

Idle Plant

The Effect of Idle Plant on Costs and Profits (65481 N). H. L. Gantt. 4 pp. Am Acad Pol & Soc Sci Ann—Sept., 1915. Advantages of not closing down.

Purchasing

Purchasing Supplies for the Panama Canal (65793 A). F. C. Boggs. From a paper at Int. Engng. Cong. 4000 w. Ir Age—Nov. 18, 1915. Methods used.

Railway Valuation

Suggested Form of Inventory for Valuation of Common Carrier Property (65764 A). D. F. Jurgensen. 1200 w. Assn Engng Socs, Jour—Oct., 1915. Forms and notes.

Valuation

Conference on Valuation (65727). 7000 w. Elec Ry Jour—Nov. 13, 1915. Serial, 1st part. Delegates in Philadelphia discuss questions in valuation work.

Reproduction Basis of Valuation Criticised (65871). John M. Eshleman. 2500 w. Eng Rec—Nov. 20, 1915. Part of Philadelphia address. Warns against government competition.

MANAGEMENT

Central Stations

Management of Electric Central Stations (65988 A). Walter N. Polokov. 3500 w. Engng Mag—Dec., 1915. Second and concluding article of series; methods of introducing scientific management into power-generating plants.

Eight-Hour Day

The Eight-Hour Day (65987 A). C. J. Morrison. 2500 w. Engng Mag—Dec., 1915. Specific examples of cases where shorter hours have lowered costs.

Promotion

The Three Position Plan of Promotion (65382 A). F. B. and L. M. Gilbreth. 3000 w. Ir Age—Nov. 4, 1915. Scheme of advancement.

Publicity

Under-Advertising of the Steel Industry (65986 A). Geo. H. Jones. 3500 w. Engng Mag—Dec., 1915. Why steel makers should advertise, what they should advertise and how.

Scientific Management

The Principles of Scientific Management (65607 A). Frederick Winslow Taylor. Abstract of an address delivered March 3, 1915. 3500 w. Ind Engng—Sept., 1915. Serial, 1st part. As regarded in its latest development, by its founder.

Scientific Management Under the X-Ray (65941 A). 3500 w. Ir Age—Nov. 25, 1915. Regarded as prejudicial to organized labor.

How to Create Industrial Leaders (65993 A). H. L. Gantt. 4000 w. Engng Mag—Dec., 1915. Basic principles of democracy on which our industrial development must be founded. First of two articles.

Scientific Management in Government Establishments (65488 B). Gen. William Crozier. 8000 w. Soc Pro Sci Man Bull—Oct., 1915. Address before Phil. School of Comm. & Accts. Status of attempts to introduce methods into arsenals.

Store-Keeping

Efficiency in the Stores Department (65365). Wilfred G. Astle. Ills. 3500 w. Elec Ry Jour—Oct. 30, 1915. Location; systems; accounting, etc.

Time Study

The Use of Time Study for Rate Setting (65608 A). Robert Thurston Kent. 5000 w. Ind Engng—Sept., 1915. Complete machine analysis by time study.

REGULATION

Arbitration

Rhode Island Wage Arbitration (65364). 2500 w. Elec Ry Jour—Oct. 30, 1915. Plea for reduction.

Government Ownership

Control and Regulation vs. Government Ownership (65726). Theodore N. Vail. 2500 w. Telephony—Nov. 13, 1915. Extract from address at dinner given N. A. Ry. Com. Perfected organization.

Patents

Les brevets d'invention internationaux (65445 D). 40 pp. Soc Ing Civ Fr Mem—April-June, 1915. Series of discussions and letter on international patents.

A Better Knowledge of Patents for Inventors (65526 A). William D. Shoemaker. 2500 w. Jour Am Soc of Marine Draftsmen—Oct., 1915. Points in patent procedure.

Public-Utilities

Regulation of Public Utilities (66033). Leonard A. Busby. 5000 w. Elec Ry Jour—Nov. 27, 1915. Difficulties of electric railway regulation; factors involved.

Railroads

The Railroads and the People (65954). William Sproule. Abstract of an address at the convention of the Am. Bankers' Assn., Seattle, Wash. 1800 w. Ry Age Gaz—Nov. 26, 1915. The public as investors; the interest of the employees.

Taxation

The Natural Taxation of Mineral Land (65394). R. B. Brinsmade. 4400 w. Min & Sci Pr—Oct. 30, 1915. Practical proposals.

Water Power

No Federal Curb on Western Power Development (65538). O. C. Merrill. Extracts from address at Portland, Ore. 1800 w. Eng News—Nov. 4, 1915. Developed far in advance of market.

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WELFARE AND SAFETY

Accident Prevention

The Prevention of Industrial Accidents (65848 A). Albert S. Regula. 2000 w. Cornell Civ Engr—Nov., 1915. Causes, educational work, safeguarding, etc.

Air Compressors

Safeguarding Air Compressors (65963 A). W. P. Eales. 1500 w. Safety Engng—Nov., 1915. Suggestions to prevent accidents.

Cranes

Safety in Crane Chain Practice (65962 A). Earl B. Morgan. 2500 w. Safety Engng—Nov., 1915. Points to be observed to secure maximum safe conditions.

Cripples

Armersatz für kriegsbeschädigte Handwerker und Arbeiter (65473 B). Kesten. Ills. 1500 w. Z V d I—Oct. 23, 1915. Device to replace arm lost in battle.

Electrical Plant

Safety and Welfare Work in an Electrical Plant (65342 A). Chester L. Lucas. Ills. 2500 w. Mach, N Y—Nov., 1915. Activities at the Pittsfield, Mass., plant of the General Electric Co.

Foundry Ventilation

Ventilation (65994 N). Ills. 1500 w. N F A Saf Bul—Nov. 1, 1915. Importance of sufficient air in foundry work and methods of obtaining it.

Housing

Housing Reform: with Special Reference to the Housing Problem in Birmingham (65455 A). Charles A. Wareing. 9 pp. Inst San Engrs Jour—Oct., 1915. General review.

Machine Shops

Safety Organization of a Machine Shop (65341 A). Luther D. Burlingame. Ills. 4000 w. Mach, N Y—Nov., 1915. Accident prevention.

Occupational Diseases

Pulmonary Disease Among Miners in the Joplin District, Missouri (65753 N). A. J. Lanza and Edwin Higgins. Ills. 35 pp. Its relation to rock dust in the mines.

Industrial Poisons Used in the Rubber Industry (65754 N). Alice Hamilton. Ills. 56 pp. U S Dept of Labor—Bul 179. Processes used and their dangers.

Painters' Scaffolds

A Safety Device for Painters' Scaffolds (65499 N). Ills. 6 pp. Trav Std—Nov., 1915. Safeguard to prevent falling.

Refrigeration

The Massachusetts Ammonia Safety Regulations (66039). Frank L. Fairbanks. Ills. 8000 w. Power—Nov. 30, 1915. Regulation affecting the use of ammonia gas in refrigeration systems.

Sand Blasting

Sand-Blasting and Other Dusty Operations (65464 N). Ills. 1200 w. N F A Saf Bull—Oct., 1915. Precautions for protecting workmen.

Welfare Work

A Study of Safety and Welfare Work in Manufacturing and Selling Organizations (65340 A). Forrest E. Cardullo. Ills. 35000 w. Mach, N Y—Nov., 1915. Study of all phases of the work.

MISCELLANY

Presidential Addresses

Presidential Address to the Institution of Civil Engineers (65784 A). Alexander Ross. 8500 w. Engng—Nov. 5, 1915. Effects of the war; national resources, and their development and use.

Presidential Address to Northeast Coast Institution of Engineers and Shipbuilders (65746 N). Herbert B. Rowell. 6500 w. N-E Coast Inst of Engrs & Shipbldrs—Nov., 1915. Military devices; the industrial situation; education and training.

Chemical Trade

The Chemical Trade and the War (65638 A). 2500 w. Engr, Lond—Oct. 22, 1915. Chemicals in demand and the supply.

Chemistry

Applied Chemistry (65515). L. H. Baekeland. Address to Am. Chem. Soc. 4500 w. Sci Am Sup—Nov. 6, 1915. Relation to manufacturers.

Dye Industry

The Dyestuff Famine (65511). Thomas H. Norton. Ills. 3000 w. Sci Am—Nov. 6, 1915. Serial, 1st part. Causes and cure.

The Dyestuff Situation (65519). 4000 w. Met & Chem Engng—Nov. 1, 1915. Papers and discussion before the N. Y. section of Society of Chemical Industry.

Exporting

How to Sell to Latin America (65985 A). Alex. Del Mar. Ills. 3500 w. Engng Mag—Dec., 1915. Authoritative discussion of conditions governing projected attempt to promote commerce.

Selling Railway Supplies to European Countries (65708). Walter S. Hiatt. 4000 w. Ry Age Gaz—Nov. 12, 1915. Methods to overcome prejudices.

South Africa's Interest in the South American Markets (65319). J. F. K. Brown. Ills. 5500 w. Coal Age—Oct. 30, 1915. Competition in coal trade.

Fuel

The World's Supply of Fuel and Motive Power (65785 A). Dugald Clerk. Thomas Hawksley lecture. Inst. of Mech. Engrs. (Abstract.) 1200 w. Engr, Lond—Nov. 5, 1915. Requirements of fuel and power in industrial civilization.

German Commerce

Le marine de commere Allemande (65451 B). Victor Cambon. Ills. 2800 w. La Nt—Oct. 16, 1915. Survey of German merchant marine.

Law and Engineering

Law and Engineering—Some Points of Contact (65469 B). Sydney G. Turner. 28 pp. Soc Engrs, Jour—Oct., 1915. With discussion.

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Merchant Marine
The Merchant Marine from a Southerner's Viewpoint (65525 A). William Gatewood. 4500 w. Am Soc of Marine Draftsmen, Jour—Oct., 1915. Advantages of a country controlling its own carrying trade.

Research
The Cash Value of Scientific Research (65651 A). T. Brailsford Robertson. 3500 w. Sci Am—Nov., 1915. Outlines wealth produced by science.

Research (65352 A). Dr. W. R. Whitney. 2200 w. Gen Elec Rev—Nov., 1915. Value of knowledge acquired.

Research and Progress in American Manufacture (65795). Dr. Raymond F. Bacon. 4500 w. Sci Am Sup—Nov. 20, 1915. Address at Nat. Ex. of Chem., Ind.

Russian Power
La question des combustibles en Russie (65454 B). J. Vichniak. 2200 w. Gen Civ—Oct. 16, 1915. Fuels and water power in Russia.

MARINE AND NAVAL ENGINEERING

Barges
Inland Navigation and Barge Construction vs. Floating Bridges (65766 N). J. H. Bernhard. Ills. 4000 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Details of a modern barge for river navigation.

Battleships
Modern Battleship Engineering (66012 A). R. H. Danforth. 5000 w. Cleveland Engng Soc, Jour—Nov., 1915. Advances made in efficiency in the navy. Short discussion.

Car Ferries
Canadian Railway Ferry-Steamer "Scotia II" (65667 A). Ills. & Plate. 1000 w. Engng—Oct. 29, 1915. Serial, 1st part. Detailed description of vessel for service across the Strait of Canso.

Diesel Engines
Diesel Engine Applied to Marine Purposes (65912). C. Kloos. From a paper read at Int. Engng. Cong. Ills. 4000 w. Power—Nov. 23, 1915. Reviews the performance of Diesel-engined ships, discussing features of design of the engines with special reference to the "Werkspoor."

Marine Diesel Engines (65528 A). Lewis B. Doane. Ills. 2500 w. Am Soc of Marine Draftsmen, Jour—Oct., 1915. Types of engines and problems in selection.

Docks
The Repairs to the Gates at the 70-Foot Entrance to the Tyne Docks (65671 A). Ills. 1000 w. Engr, Lond—Oct. 29, 1915. Novel methods.

Dry Docks
Pearl Harbor Dry Dock (66024 D). Ills. 4500 w. Am Soc Civ Engrs, Pro—Nov., 1915. Continued discussion of H. R. Stanford's paper.

Electric Propulsion
Some Comparisons Relating to Electric Propulsion of a Battleship (65598 N). W. L. R. Emmet. Ills. 1000 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Machinery of the California.

Fire Float
Motor Fire Float Delta II (65368 A). Ills. 1000 w. Int Marine Engng—Nov., 1915. Shallow draft vessel driven by kerosene motor.

Fleet Maintenance
The Maintenance of the Fleet (65602 N). A. P. Niblack. Map. 3000 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Preparation for defense.

Gyro-Stabilizer
Recent Progress with the Active Type of Gyro-Stabilizer for Ships (65765 N). Elmer A. Sperry. 3000 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Equipment placed on the yacht Widgeon, owned by H. M. Hanna, Jr.

Hog and Sag
Data on Hog and Sag of Merchant Vessels (65600 N). T. M. Cornbrooks. Curves. 1000 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Panama colliers Nos. 1 and 2, Ulysses and Achilles.

Interior Decoration
Interior Decoration of Vessels (65599 N). Harry B. Etter. Ills. 5000 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Criticism and suggestions.

Lighthouse Tender
New U. S. Ship for Pacific Coast (65359 A). Ills. 1200 w. Marine Rev—Nov., 1915. Details of lighthouse tender, Fern.

Motor Ships
The Western Australian Government Motor-Ship "Kangaroo" (65781 A). Ills. 1200 w. Engng—Nov. 5, 1915. Ship driven by Diesel engines, for service between Australia and England.

Het motorschip "Mijer" der Koninklijke Paketvaart-Maatschappij (65437 B). W. J. Muller. Ills. 7000 w. Ingenieur—Oct. 23, 1915. Driving mechanism of Diesel-engined Dutch ship.

Oil Engines
Marine Oil Engines for Commercial Work (65370 A). Ills. 1500 w. Int Marine Engng—Nov., 1915. Construction and operation; application to work boats.

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Power Boats

Power Boats for National Defense (65358 A). Ills. 2000 w. Marine Rev—Nov., 1915. Proposed plan.

Resistance

The Determination of the Resistance of Ships. Present Day Status of the Art (65596 N). Ernest H. Rigg. 3500 w. Also bibliography. Soc Nav Archts & Marine Engrs—Nov., 1915. Review of present knowledge on the subject of powering ships.

Variation of Frictional Resistance of Ships with Conditions of Wetted Surface (65595 N). William McEntee. Ills. 1500 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Tests at U. S. Experimental Model Basin.

River Steamers

Western River Steamers and Barges (65367 A). Ills. E. A. Burnside. 3000 w. Int Marine Engng—Nov., 1915. Construction of towboats and barges.

Sail Experiments

Aerodynamical Experiments Upon a Yacht's Mainsail (65594 N). H. A. Everett. Ills. 3500 w. Soc Nav Archts and Marine Engrs—Nov., 1915. At Massachusetts Institute of Technology. Experimental work and results.

Salvaging

Raising the Submarine F-4 (65540). Ills. 4000 w. Eng News—Nov. 4, 1915. Account of work in Honolulu harbor.

Ship Auxiliaries

Ship Auxiliaries (65529 A). G. E. Smith. 2500 w. Am Soc of Marine Draftsmen, Jour—Oct., 1915. Vessel handling machinery.

Ship Brake

Results of Model Tank Experiments to Determine the Action of a Ship Brake (65597 N). William Strother Smith. Ills. 1200 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Data for use in determining whether or not it was feasible to install a brake to assist in stopping a steamer when in danger.

Stability

A Method of Estimating the Stability Required by a Ship (65924 A). Arthur R. Liddell. 1500 w. Engr, Lond—Nov. 12, 1915. Suggestions and explanation.

Submarines

The Submarine of To-day and To-morrow (65768 N). L. Y. Spear. 8500 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Mechanical development; design problems; types; and present outlook.

Het gebruik en de inrichting van onderzeesche vaartuigen (65975 B). W. F. Pot. Ills. 15000 w. Ingenieur—Nov. 6, 1915. General review of submarine design, machinery and handling.

The Submarine Power Plant (65696 A). Allen Hoar. Ills. 3500 w. Sib Jour of Engng—Nov., 1915. Systems tried and their defects.

Superheated Steam

Superheated Steam in Marine Practice (65603 N). Henry B. Oatley. Ills. 8800 w. Soc Nav Archts & Marine Engrs—Nov., 1915. The position now occupied.

Tugs

The Diesel Motor Tug Chickamauga (65369 A). George E. Nicholson. Ills. 1000 w. Int Marine Engng—Nov., 1915. Designed for towing on Puget Sound.

Turbines

The Application of the Steam Turbine to Marine Propulsion (65662 A). J. F. Metten. Ills. 2500 w. Marine Engr & Nav Archt—Nov., 1915. Serial, 1st part. Outlines various methods of application and the work for which each seems adapted.

The Application of Small Steam Turbines for Auxiliary Purposes on Board Ship (65767 N). W. J. A. London and Frederick D. Herbert. Ills. 8500 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Applications and details of design.

Vibration

Period of Vibration of Steam Vessels (65601 N). William Gatewood. Curves. 4500 w. Soc Nav Archts & Marine Engrs—Nov., 1915. Investigations and methods.

MECHANICAL ENGINEERING

AERONAUTICS

Aeroplane Engines

Twin-Six Engines for Aeroplanes (65648). Frederick Eppelsheimer. Ills. 1700 w. Sci Am—Nov. 13, 1915. Requirements and types.

The New 8-Cylinder 135 H. P. Thomas Aeromotor (65434). Ills. 500 w. Aer Age—Nov. 1, 1915. Detailed specifications.

Clothing and Equipment

Clothing and Equipment for Aviators (65458). Aerntcs—Oct. 27, 1915. Serial, 1st part. General article.

Engines

Engine Power at High Altitudes (65487). Neil MacCoull. Ills. 1200 w. Aer Age—Nov. 22, 1915. Effect of rarified air on capacity.

Flying Boats

The New Thomas Flying Boat (65433). Ills. 500 w. Aer Age—Oct. 25, 1915. Brief description of design.

Planes

Variably-Curved Planes (65432 A). Robert Mallet. Ills. 2000 w. Aerntcs—Oct. 13, 1915. Translated from *L'Aérophile*. Account of experiments.

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Propeller Machine

The Wadkin Propeller-Shaping Machine (65497 A). Ills. 1000 w. Aerntcs—Nov. 10, 1915. Device for reproducing exact shape of model.

AUTOMOBILES

Engines

Vast Progress in Motor Design (65383). A. Ludlow Clayden. Ills. 5000 w. Automobile—Nov. 4, 1915. Improvements.

Stating the Case for the Eight (65384). Charles S. Crawford. From a paper read before the Indiana Sec. S. A. E. Ills. Also discussion. 7500 w. Automobile—Nov. 4, 1915. Compares eights and twelves for balance and efficiency.

Piston Practice (65676). James E. Diamond. Read before S. A. E. Ills. 6500 w. Automobile—Nov. 11, 1915. Advantages of aluminum alloy.

Aluminum Alloy Pistons (65548). Morris R. Machol. Ills. 3500 w. Horseless Age—Nov. 1, 1915. Advantages; comparison of cost.

Farm Tractors

Traction mecanique et motoculture (65428 B). B. et L. La Nat—Oct. 23, 1915. Recent developments in field of farm motor traction.

Fuels

Versuchergebnisse mit Benzolspiritusmischungen bei dem Betrieb von Kraftwagen (65417 B). Frhr. v. Löw. Ills. 1200 w. Aut-Rnd—Sept., 1915. Results of experiments with benzol-alcohol mixture for driving automobiles.

Ueber Benzol (65418 B). P. Martell. 2000 w. Aut-Rnd—Sept., 1915. Brief note on nature and use of benzol in automobiles.

Gearsets

Gearsets Are Smaller and Lighter (65820). Ills. 1800 w. Automobile—Nov. 18, 1915. Development.

Indicators

Recent Developments in Optical Indicators (65549). Ills. 1200 w. Horseless Age—Nov. 1, 1915. New two mirror instrument recently developed in England. Also Schulze single mirror indicator.

Use of Optical Indicators for Checking Defects in Functioning of Motors (65997). Ills. 3500 w. Automobile—Nov. 25, 1915. Serial, 1st part. From the German viewpoint as given in *Auto-Technik*.

Military

Das Automobil im Kriege (65416 B). Hofmann-Braunschweig. 3000 w. Aut-Rnd—Sept., 1915. General discussion of the performance of automobiles in the present war.

Motor Trucks and Modern Warfare (65510). Joseph Brinker. Ills. 2800 w. Sci Am—Nov. 6, 1915. Subsidy systems.

Motor Trucks

Dummies Play Important Part in Fender Tests (65568). Ills. 1000 w. Eng Rec—Nov. 6, 1915. Specifications for motor-truck fenders.

Refrigerator Automobiles

Les automobiles frigorifiques de l'armée Italienne (65463 B). Gouriet. Ills. 1200 w. Gen Civ—Oct. 23, 1915. Cold-storage machines for transporting meat to Italian troops at front.

Road Locomotives

New Gas-electric Tractor—A Road Locomotive (65373 A). Ills. 700 w. Com Veh—Nov. 1, 1915. German machine operating on multiple unit plan.

Springs

Scientific Spring Making (65663 A). Ills. 2500 w. Autocar—Oct. 30, 1915. American mechanical processes.

Steering

Steering Gears Offer Many Problems (65819). A. Ludlow Clayden. Ills. 2200 w. Automobile—Nov. 18, 1915. Opportunities for design.

Verbesserung der Schraubenspindelsteuerung (65438 B). C. Rath. Ills. 2000 w. Schiffbau—Oct. 13, 1915. Details of mechanical improvements in screw-spindle steering mechanism.

Suspension

An Adjustable Cantilever Suspension (65771 A). Ills. 1500 w. Autocar—Nov. 6, 1915. Invention of O. D. North. Device giving equal comfort with light or full loads.

Trailers

Trailer Economy Makes Trucks More Efficient (65372 A). Joseph Husson. Ills. 2500 w. Com Veh—Nov. 1, 1915. Serial, 1st part. How savings are effected.

Transmission

A Car with Electro-Magnetic Transmission (65958). Ills. 1000 w. Sci Am—Nov. 27, 1915. A solution of the change-speed gear problem.

COMBUSTION MOTORS

Carbureters

Carburetter for Internal-Combustion Engines (65385 A). Ills. 900 w. Mech Engr—Oct. 22, 1915. Device for controlling engine speed.

Diesel Engines

The Diesel Engine and Its Applications in Southern California (65604 A). Walter H. Adams. Ills. 6000 w. Am Soc Mech Engrs, Jour—Nov., 1915. Read at San Francisco. Outlines design and tendencies and operation with various fuels.

McIntosh & Seymour 500-Hp. Diesel Engine (66036). F. R. Low. Ills. 3000 w. Power—Nov. 30, 1915. Vertical 4-cylinder engine.

See also MARINE AND NAVAL ENGINEERING.

Gas Engine Plants

Gas Engines Replace a Steam Turbine Power Plant (65743). C. L. Follmer. Ills. 3000 w. Power—Nov. 16, 1915: Plant of the Monongahela Valley Traction Co., near Fairmont, W. Va.

Gas Engines

See Researches under *Heating and Cooling*.

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Gasoline Engines

Effects of Varying Mixture and Ignition Timing (65911). Victor R. Gage. 800 w. Power—Nov. 23, 1915. Action of a gasoline engine with different fuel mixtures and different timing of the spark judged by comparing indicator diagrams.

Gas Producers

Wood-Gas Plants for Mines (65430 A). W. R. Degenhardt. Ills. 2000 w. Min Mag—Oct., 1915. Practice in Western Australia.

Generator Gas

Ueber den Methangehalt im Generatorgas aus Koks (65407 B). F. Hoffmann. Ills. 2400 w. Glck—Oct. 2, 1915. Investigation of factors determining methane percentage in gas from coke-fired generators.

Humphrey Pump

See *Hydraulic Machinery.*

Ignition

Die Zündgeschwindigkeit brennbarer Gasgemische (65474 B). Wilhelm Nusselt. Ills. 4500 w. Z V d I—Oct. 23, 1915. Development of formulas for the velocity of ignition of gases.

Oil Engines

The Heavy Oil Engine, Its Present Status, and Future Development (65605 A). A. H. Goldingham. Ills. 4000 w. Am Soc Mech Engrs, Jour—Nov., 1915. Read at San Francisco. Both Diesel and hot surface types, with new cost data.

See also MARINE AND NAVAL ENGINEERING.

HEATING AND COOLING

Ammonia

Effect of Superheated Ammonia on Compressor Capacity (65612). H. R. Howell. 1800 w. Power—Nov. 9, 1915. Importance of temperature.

Decomposition of Ammonia and the Chances of Explosions (65909). Frank L. Fairbanks. 2500 w. Power—Nov. 23, 1915. Experiments in a large refrigerating plant fail to produce an explosion of ammonia gas by detonation.

Central Plants

Central Heating Plants (65399). Charles L. Hubbard. 2500 w. Nat'l Engr—Nov., 1915. Methods of estimating cost of operation and maintenance.

Combination Plants

See ELECTRICAL ENGINEERING, *Generating Stations.*

District Heating

District Heating System at Whitby, Ont. (65881). J. Lanning. Ills. 1500 w. Can Engr—Nov. 18, 1915. Heating and ventilating system for the Hospital for the Insane.

Heat Losses

Report of the Establishment of a Standard Coefficient for Heat Losses Affected by Wind Movement (65760 D). H. W. Whitten and R. C. March. 700 w. Am Soc Heat & Vent Engrs, Jour—Oct., 1915. Part of a report read at the Chicago Convention, June, 1915.

Heat Transmission

See Researches.

Hot-Water Heating

Hot Water Heating Systems (65397). George E. Reid. Diagrams. Lecture before N. A. S. E., Washington, D. C. 3000 w. Nat'l Engr—Nov., 1915. Philosophy of circulation.

Hot Water Heating on a Large Scale (65809). Ills. 2200 w. Heat & Vent Mag—Nov., 1915. Central heating plant for the state school of agriculture, Farmingdale, L. I.

Ice

Experimental Studies and Observations on Ice Structure (65652 B). O. D. von Engeln. Ills. 7500 w. Am Jour of Sci—Nov., 1915. Experiments and results.

Specific Heat and Heat of Fusion of Ice (65968 N). H. C. Dickinson and N. S. Osborne. Ills. 33 pp. U S Bureau of Stand—Oct. 28, 1915. Determination of constants of importance in the design and operation of refrigerating machinery.

Light and Refrigeration

Elektrizitätswerk, Eisfabrik, Kühl- und Gefrierhaus (65420 B). Richard Pabst. Ills. 3000 w. E K u B—Oct. 14, 1915. Advantages of combining lighting plant with refrigeration, with Berlin example.

Neutral Zone

Can We Locate the Neutral Zone in Heated Buildings? (65811). J. J. Blackmore. Ills. 2500 w. Read at Atlantic City meeting of Am. Soc. of Heat. & Vent. Engrs. Heat & Vent Mag—Nov., 1915. Physical facts involved; examples.

Piping Chart

New Pipe Chart and Tables Based on Square Feet of Radiation (65810). T. W. Reynolds. 1000 w. Heat & Vent Mag—Nov., 1915. For use in determining sizes of mains and branches for low-pressure steam-heating systems.

Progress

Progress of Heating and Ventilating Art in the Last Decade (65694 A). Rolla C. Carpenter. Read before Int. Engng. Cong. 2800 w. Sib Jour of Engng—Nov., 1915. General character of improvements.

Recirculation

Tests on the Recirculation of Washed Air (65759 D). G. L. Larson. Ills. 8500 w. Am Soc Heat & Vent Engrs, Jour—Oct., 1915. Tests of system in University of Wisconsin High School.

Refrigeration

Overhauling the Refrigerating Plant (65351). A. G. Solomon. Ills. 1800 w. Prac Engr, Chicago—Nov. 1, 1915. Hints to avoid unnecessary labor and expense.

Vapor - Compression Refrigeration (65806 N). J. H. Grindley. Plates. 38 pp. Inst Civ Engrs of Ireland, Trans—Vol. XLI. Part I describes vapor-compression refrigerating machines and the theory of their action. Part II gives new diagrams for the properties of CO_2 and NH_3.

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Researches

Notes on Some Recent Researches (65747 N). J. E. Petovel. Ills. 50 pp. Manchester Assn. of Engrs—Oct. 30, 1915. Part I. Heat transmission. Part II. Heat flow and ventilation. Part III. Gas engine research. Part IV. Strength of structures.

Schools

Heating and Ventilating Plant, Waite High School, Toledo, Ohio (65758 D). Samuel R. Lewis. Ills. 1800 w. Am Soc Heat & Vent Engrs, Jour—Oct., 1915. Equipment of this plant.

Power Plant of a Model School (65395). R. J. Mullin. Ills. 3500 w. Natl Engr—Nov., 1915. High school at Tacoma, Wash. Interesting details. Oil fuel system.

Ventilation

Development in Mechanical Ventilation Hygienically, Above Ground, Under Ground, and Under Deck (65929 A). James Keith. Ills. From a paper read before the Inst. of Marine Engrs. 1800 w. Col Guard—Nov. 5, 1915. Design of ventilating systems.

See also Researches.

HYDRAULIC MACHINERY

Air Lifts

The Quebec Bridge Pumping Plant. (65999). J. W. Davis. Ills. 1500 w. Can Engr—Nov. 25, 1915. Details of air lift system with booster.

Air-Pumps

Condensers and Willans-Müller Air-Pumps (65931 A). Ills. & Plate. 2500 w. Engng—Nov. 12, 1915. Detailed description.

Centrifugal Pumps

How Low Fixed Charges Favor Centrifugal Pumps (65541). G. H. Gibson. Ills. 1800 w. Eng News—Nov. 4, 1915. Comparison of economic results.

Chemi-Hydrometry

See Flow under CIVIL ENGINEERING, *Measurement.*

Humphrey Pump

The Humphrey Pump: Recent Developments (65695 A). Charles C. Trump. Ills. 2000 w. Sib Jour of Engng—Nov., 1915. Improvements; ignition problems.

Turbines

Fortschritte im Bau der Wasserturbinen (65490 B). W. Wagenbach. Ills. 3000 w. Z V d I—Nov. 6, 1915. Serial, 1st part. Review of progress in construction of water turbines especially as exhibited at the 1914 Berne exposition.

Further Means Suggested for Interpretation of Water-Turbine Test Data (65336). L. F. Harza. Ills. 2800 w. Eng Rec—Oct. 30, 1915. Five new features to help visualize turbine characteristics.

Neueste Typen schnellaufender Wasserturbinen (65465 B). W. Zuppinger. Ills. 3000 w. Schw Bau—Oct. 23, 1915. Serial, 1st part. Design of recent Swiss types of high-speed turbines.

Design of Turbine Draft Tubes Analyzed (65725). 3500 w. Eng Rec—Nov. 13, 1915. Serial, 1st part. New formula derived for reduction of velocity of water leaving turbine.

Die Anwendung grosser Stützkugellager für vertikalachsige Wasserturbinen in der Schweiz. (65480 B). Max F. C. Schoch. Ills. 2000 w. Schw Bau—Oct. 30, 1915. Swiss use of ball bearings for supporting thrust of vertical water turbines.

Valve Wear

Der Einfluss des Kohlensäuregehaltes des Wassers auf die Haltbarkeit von Pumpenventilen (65977 B). Ills. 2000 w. Poly Rund—Oct. 30, 1915. Experience in the Oldenburg pumping plant with valve wear from CO_2 content in water.

MACHINE ELEMENTS AND DESIGN

Ball Bearings

See Turbines under *Hydraulic Machinery.*

Design

Gemeinsame Probleme des Maschinenbaues (65456 B). K. Kutzbach. Ills. 4500 w. Z V d I—Oct. 16, 1915. Serial, 1st part. Problems in machine design, especially cranks.

Gear Teeth

The Strength of Gear Teeth (65606 A). Guido H. Marx and Lawrence E. Cutter. Ills. 5500 w. Am Soc of Mech Engrs, Jour—Nov., 1915. Read at San Francisco. Allowable stress.

Strength of Wheel Teeth (65624 A). W. M. Wallace. 1000 w. Prac Engr—Oct. 28, 1915. Derives formula.

Machine Proportioning

Some Aids to Designing (65514). Ills. 1500 w. Sci Am Sup—Nov. 6, 1915. From *English Mechanic.* Proportioning machines to size of man.

Pipe

Spiral Riveted Pipe (65738). C. B. Linstrom. Ills. 1200 w. Boiler Maker—Nov., 1915. Pattern for heavy plate.

Shafts

Determination of Shaft Diameters (65634 A). 200 w. Mech Wld—Oct. 29, 1915. Chart and its use.

Springs

Federschwingungen mit besonderer Berücksichtigung des Eisenbahnwagenbaues (65400 B). Hans Hermann. Ills. 2500 w. Gla Ann—Oct. 1, 1915. Serial, 1st part. Mathematical examination of spring oscillation especially as applied to railroad cars.

MACHINE WORKS AND FOUNDRIES

Automatic Devices

Torres and His Remarkable Automatic Devices (65516). Ills. 2000 w. Sci Am Sup—Nov. 6, 1915. Remarkable work of a Spanish inventor.

Automatic Machines

Automatic Machine Development (65518). Ralph E. Flanders. Read at Int. Engng. Cong. Ills. 5000 w. Ir Trd Rev—Nov. 4, 1915. Applications; relation to production.

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Automatic Machine Tools and Processes (65633 A). A. G. Robson. Ills. 700 w. Mech Wld—Oct. 29, 1915. Serial, 1st part. Design and construction.

Brass Founding

Deoxidizing Brass and Bronze (65844). 800 w. Brass Wld—Nov., 1915. The best deoxidizers.

Case Hardening

See Heat Treatment.

Die Casting

Die-Casting Practice (65847). Charles Pack. 2200 w. Brass Wld—Nov., 1915. Processes in use; alloys used; etc.

Dies

Typing, Punching and Holding Dies (65926 A). Joseph Horner. Ills. 1000 w. Mech Wld—Nov. 12, 1915. Directions for the work.

The Adjustment of Split Screwing-Dies (65632 A). Joseph Horner. Ills. 700 w. Mech Wld—Oct. 22, 1915. Serial, 1st part. Types in use; methods of adjustment.

Drawings

Suggestions for Reading Working Drawings (65371). Fred West. Ills. 2000 w. Foundry—Nov., 1915.

Flywheels

Modellierung und Formerei von Schwunggrädern (65484 B). Ills. 2000 w. St u E—Oct. 28, 1915. Methods of making patterns and forms for flywheels.

Forging-Presses

Quick-Acting Forging-Presses (65933 A). A. J. Capron. Read before the Int. Engng. Cong. Ills. 4000 w. Engng—Nov. 12, 1915. Improved presses and their applications and operation.

The Rapid Production of Heavy Forgings (65940 A). 2500 w. Ir Age—Nov. 25, 1915. Review of A. J. Capron's paper, read before the Int. Engng. Cong. Forging press as competitor of hammer for heavy forgings.

Foundry Practice

Modern Iron-foundry Practice (65778 A). W. Rawlinson. From a paper before the Jun. Inst. of Engrs. 1500 w. Mech Wld—Nov. 5, 1915. Serial, 1st part. Cupola design; coke consumption; air supply; metal mixtures, etc.

Good Sense in the Steel Foundry (65683). G. Muntz and E. Roubieu. Ills. 4000 w. Ir Trd Rev—Nov. 11, 1915. Causes and cures of troubles.

Fuel Domes

Bosh Fuel Domes (65750 B). Frederick Louis Grammer. 2200 w. Engrs' Soc of W Penn, Pro—Oct., 1915. Study of conditions.

Grinding

Guest's Theory of Grinding (65641 A). 3000 w. Engr, Lond—Oct. 22, 1915. Critical discussion of J. J. Guest's paper, read before the Inst. of Mech. Engrs.

Grinding Wheel Truing Devices (65344 A). Douglas T. Hamilton. Ills. 6000 w. Mach, N Y—Nov., 1915. Attachments for applying diamond tools.

Heat Treatment

Die Wärmebehandlung der Metalle (65401 B). J. Czochralski. Ills. 1500 w. Gie Z—Oct., 1915. Certain points in heat treatment of copper alloys.

The Heat Treatment of Iron and Steel in a Neutral Atmosphere (65717). Alfred H. White and Homer T. Hood. Shows it is possible to heat iron and steel in an internally fired muffle without any oxidation or formation of scale.

Materials Employed in Case Hardening (65379 A). R. A. Millholland. 1500 w. Ir Age—Nov. 4, 1915. Compares natural and manufactured materials.

Case-Hardening Retorts and Furnaces (65679 A). R. A. Millholland. Ills. 2500 w. Ir Age—Nov. 11, 1915. Materials employed; types of furnaces.

The Process of Case Hardening (65792 A). R. A. Millholland. 1800 w. Ir Age—Nov. 18, 1915. Influence of time and temperature.

Lathe Control

Automatic Control Gear for Lathes (65935 A). Ills. 1200 w. Engng—Nov. 12, 1915. Details of a system claiming to provide a large rangs of speeds without changing gears or shifting belts, and other advantages.

Limit System

The Limit System in the Drawing-Office (65927 A). Ills. 1000 w. Mech Wld—Nov. 12, 1915. The essentials of the system.

Patterns

Unique English Gear Pattern Making Machine (65846). Frank C. Perkins. Ills. 700 w. Brass Wld—Nov., 1915. Interesting mechanical wood worker.

Projectiles

Lavorazione degli Shrapnels (65467 B). G. Orlandi. Ills. 1800 w. Indus—Oct. 24, 1915. Serial, 1st part. Compilation of information on shrapnel manufacture.

Shells of the Calibers Now in Service (65380 A). C. A. Tupper. 4000 w. Ir Age—Nov. 4, 1915. Information for munitions manufacturers.

Sand Preparation

Die Sandaufbereitungsvorrichtungen der Alfred Gutmann Aktiengesellschaft für Maschinenbau, Altona-Ottensen (65402 B). Ills. 1800 w. Gie Z—Oct., 1915. Serial, 1st part. Methods and machines for preparing molding sand at Gutman plant in Altona, Germany.

Steel Helmets

Manufacture of Steel Helmets for the French soldiers (65959). Jacques Boyer. Ills. 900 w. Sci Am—Nov. 27, 1915. Why and how two million were made in six months.

Tumbling

Tumbling as a Means of Preparing Work for Finishing (65928 A). 1500 w. Mech Wld—Nov. 12, 1915. Tumbling barrels and their use; media for polishing and finishing.

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Welding

Oxyacetylene Welding Practice (65343 A). S. W. Miller. Ills. 5500 w. Mach, N Y—Nov., 1915. Welding of malleable iron and copper and copper alloys.

MATERIALS OF CONSTRUCTION

Abrasives

The Production of Abrasive Materials in 1914 (65755 N). Frank J. Katz. 20 pp. U S Geol Surv, II: 29—Oct. 26, 1915. Statistics.

Boiler Plugs

An Investigation of Fusible Tin Boiler Plugs (65661 N). George K. Burgess and Paul D. Merica. Ills. 35 pp. U S Bureau of Stand, Tech paper 53—Oct. 15, 1915. Importance of pure tin.

Electric Steel

Electric Furnace Steels for Dynamic Stresses (65675). J. Edward Schipper. Ills. 5000 w. Automobile—Nov. 11, 1915. Improved methods giving stronger materials.

Firebrick

Characteristics of Firebrick for Boiler Furnaces (65715). E. H. Tenney. Ills. 1500 w. Elec Wld—Nov. 13, 1915. Effect of furnace conditions on firebrick.

Iron and Steel

Ueber das Verhalten mehrerer Eisen- und Stahlsorten beim Druckversuch (65423 B). Herbert Monden. Ills. 3000 w. St u E—Oct. 7, 1915. Serial, 1st part. Results of experiments on behavior of certain irons and steels under compression.

Der Einfluss von Temperatur und mechanischer Arbeit beim Presschmieden von Flusseisen und Stahl (65491 B). Otto Fuchs. Ills. 2000 w. Z V d I—Nov. 6, 1915. Results of experiments by commission to determine effects of heat and working on wrought iron and steel in the forge press.

Recherches sur les alliages de fer, silicium et carbone (65466 C + D). Georges Charpy and André Cornu-Thenard. Ills. 26 pp. Rev de Met—June, 1915. Investigation of thermal, chemical and structural characteristics of cast iron and steel carrying varying quantities of silicon and carbon.

Manganese-Bronze

Manganese - Bronze from Scrap (65845). J. B. Rhodes. 1200 w. Brass Wld—Nov., 1915. The production of manganese-bronze ingots, the materials used and foundry practice.

Monel Metal

Monel Metal (65815 D). Charles M. Biddle, Jr. 1600 w. Ohio Soc Mech, Elec, & Steam Engrs, Jour—Vol. VIII. No. 1. A natural alloy of nickel and copper. The ore and process of extracting.

Non-Ferrous Materials

Review of Non-Ferrous Materials Formerly Used; and of Some Worth Further Consideration for Turbine Blading Purposes (65789 A). Ills. 3500 w. Engr, Lond—Nov. 5, 1915. Materials and requirements for blading.

Platinum Ware

A Study of the Quality of Platinum Ware (65974 N). George K. Burgess and P. D. Sale. Ills. 27 pp. U S Bureau of Stand—Nov. 8, 1915. Thermoelectric method for determining the purity of platinum ware, and its application.

Rubber

Reclaimed Rubber (65786 A). 2000 w. Engr, Lond—Nov. 5, 1915. Methods and objects of reclaiming.

Sherardizing

General Electric Practice in Sherardizing (65678 A). Ills. 2000 w. Ir Age—Nov. 11, 1915. Methods and tests.

MEASUREMENT

Calorimeters

An Aneroid Calorimeter (65967 N). H. C. Dickinson and N. S. Osborne. Ills. 25 pp. U S Bureau of Stand—Oct. 28, 1915. General principles of design, description, calibration, and experiments.

Convex Heads

Stresses in Convex Heads (65744). F. F. Couch. Ills. 2000 w. Power—Nov. 16, 1915. Exceptions to analyses of stresses given in previous discussions.

Currents

Induced Currents of Fluids (66023 D). Ills. 2500 w. Am Soc Civ Engrs, Pro—Nov., 1915. Discussion of F. zur Nedden's paper.

Flue-Gas

Calculating Dry Flue-Gas Loss (66037). Carleton W. Hubbard. 2500 w. Power—Nov. 30, 1915. Method of determining the dry flue-gas loss, in relation to the carbon-dioxide contents.

Gases

Messgeräte für Druck und Geschwindigkeit von Gasen (65419 B). Ills. 2000 w. Z V d I—Oct. 9, 1915. Serial, 1st. part. Construction and use of series of instruments for measuring gas pressure and velocity.

Metallography

Hauptarten der Aetzerscheinungen und die metallographischen Aetzverfahren (65460 B). J. Czochralski. Ills. 3000 w. St u E—Oct. 21, 1915. Serial, 1st. part. Etching of polished sections of rocks and metals.

Planimeters

The Polar Planimeter (65378). S. B. Redfield. Diagrams. 1300 w. Power—Nov. 2, 1915. Principle of its operation.

Power-Plant Recorders

Recording Power Plant Operations (65990 A). Julian C. Smallwood. Ills. 4000 w. Engng Mag—Dec., 1915. Fourth and concluding installment of series, taking up filing and interpreting.

Pyrometry

Characteristics of Radiation Pyrometers (65970 N). George K. Burgess and Paul D. Foote. Ills. 85 pp. U S Bureau of Stand—Oct. 28, 1915. Principles; types of instruments, calibration, sources of error, and adaptability.

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Shafts

Die günstigsten Abmessung raschlaufender Wellen mit Rücksicht auf ihre kritische Drehzahl (65979 B). Heinrich Holzer. Ills. 3000 w. Z g T—Oct. 30, 1915. Mathematical considerations in design of high-speed steam-turbine shafts.

Steel Testing

Tests on Various Steels with an Improved Torsion Testing Machine (65800 N). W. E. Lilly. Ills. 23 pp. Inst Civ Engrs of Ireland, Trans—Vol. XLI. Improved machine and its use, with discussion of results.

Turbine Blades

Berechnung von Schaufelstärken von Turbinenlaufrädern (65457 B). R. Camerer. Ills. 1600 w. Z V d I—Oct. 16, 1915. Calculations of the thickness of hydraulic turbine rotor blades.

Weights

Weights of Elements (65513). John Waddell. 2500 w. Sci Am Sup—Nov. 6, 1915. From *Chem. News*. Principles underlying choice of standard weights.

POWER AND TRANSMISSION

Air Compressors

Centrifugal Air Compressors (65625 A). Ills. 1300 w. Prac Engr—Oct. 28, 1915. Surging effects.

Chain Drive

The Use of Chain-Drives in Textile Machines (65932 A). Ills. 2000 w. Engng—Nov. 12, 1915. Deals particularly with "internal drives of textile machines."

Construction Plants

Selecting Construction Power-Plant System (65826). Editorial review. 3400 w. Eng News—Nov. 18, 1915. Advantages of steam, electricity, gasoline and compressed air for various services.

Waste Heat

Die Abwärmeverwertung im neuzeitlichen Kraftbetrieb (65461 B). B. Schapira. Ills. 2500 w. Feuer—Oct. 15, 1915. Serial, 1st. part. Power plants using waste heat as gases from blast furnaces and coke ovens.

STEAM ENGINEERING

Boiler Design

The Steam Boiler of 1915 (65614). Arthur D. Pratt. Ills. Read at Engng. Cong., San Francisco. 8500 w. Power—Nov. 9, 1915. Design of boilers.

Some Elements of Smokeless Furnace Design (65814 D). Osborn Monnett. Ills. 2000 w. Ohio Soc Mech, Elec, & Steam Engrs, Jour—Vol. VIII. No. 1. Ways of improving settings from a smoke standpoint.

Boiler Economy

Limiting Factors in Forcing Boilers Above Rating (65375). Theodore Maynz. Ills. 2800 w. Power—Nov. 2, 1915. Conditions that limit forcing and alterations in changing rating.

Boiler Operation

Sudden Cooling of Boilers in Cases of Low Water (65745). R. N. Blackburn. 3000 w. Power—Nov. 16, 1915. Defense of the statement that sudden cooling of overheated boiler plates is the safest practice.

Coal Purchasing

Some Technical Aspects of the New York Specifications (65322). Reginald Trautschold. 2000 w. Coal Age—Oct. 30, 1915. Critical discussion of requirements.

Condensers

Interpreations of Data on Steam-Condenser Performance (65714). H. A. Cozzens, Jr. 1500 w. Elec Wld—Nov. 13, 1915. Formulas and calculations convenient for checking operation.

Barometric Condenser Drain (65863). H. R. Bissell. Ills. 1200 w. Coal Age—Nov. 20, 1915. Practical method of draining a water pocket in piping carrying steam under 28 in. of vacuum.

Draft

Draft in Furnaces and Flues (65610). E. G. Bailey. Ills. 4000 w.(Power—Nov. 9, 1915. Why there is less draft at some points beyond the furnace than in the furnace.

Exhaust Steam

The Utilization of Exhaust Steam (65330). O. Bechstein. Abstract from *Prometheus*. Ills. 1000 w. Sci Am Sup—Oct. 30, 1915. Systems for promoting economy of fuel.

Feed Water

Neutralizing and Softening Mine Drainage Water (66001). J. R. Campbell. Ills. 2200 w. Coal Age—Nov. 27, 1915. Treated with lime and soda-ash.

Flue Gases

How Much CO_2 to Expect (65908). Victor J. Azbe. 1500 w. Power—Nov. 23, 1915. Maximum percentages of CO_2 obtainable with various kinds of fuel.

Fuels

Mischungsverbrennung (65409 B). A. Dosch. Ills. 1500 w. Feuer—Oct. 1, 1915. Serial, 1st part. Investigation of methods and results of burning hard and soft coal together.

Furnaces

La teoria di Groume-Grjimaïlo sui forni a fiamma (65426 B). Umberto Savoia. 19 pp. Coll Ing Ar Att—Aug., 1915. Explanation of the Groume-Grjimaïlo theory on the nature of flames in furnaces.

Gas Explosions

Gas Explosions in Boilers (65613). Reginald Trautschold. 3000 w. Power—Nov. 9, 1915. Cause and prevention.

Pipe Drainage

Draining High-Pressure Steam Piping (65376). Charles L. Hubbard. Ills. 2000 w. Power—Nov. 2, 1915. Requirements of drainage systems.

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Piping

Boiler Feed Piping (65737). From *The Locomotive.* Ills. 3500 w. Boiler Maker—Nov., 1915. Arrangement of the internal and external feed piping.

Power Plants

Unusual Features in Factory Plant (65350). Ills. 1800 w. Prac Engr, Chicago—Nov. 1, 1915. Plant at Kimberly, Wis.

"Soot"

"Soot"—Its Composition, Its Effect on Boiler Efficiency, Its Removal by Mechanical Soot Cleaners (65817 D). F. A. Moreland. 4000 w. Ohio Soc Mech, Elec, & Steam Engrs, Jour—Vol. VIII. No. 1. The use of such cleaners and precautions necessary.

Steam Accumulators

Betriebserfahrungen mit Dampfspeichern (65478 B). Ills. 5000 w. Glck—Oct. 23, 1915. Results of operation with steam accumulators at a number of plants.

Steam Traps

The Rolling Ball Trap (65816 D). C. S. Brown and A. A. Cryer. Ills. 3000 w. Ohio Soc Mech, Elec, & Steam Engrs, Jour—Vol. VIII. No. 1. The requirements of steam traps and description of device named.

Turbines

Steam Turbine Operation (65398). Frederick L. Ray. Ills. 2000 w. Natl Engr—Nov., 1915. Instructions.

Das Wesen der Abdampf- und der Zwischendampfverwertung sowie deren Einfluss auf die Verbilligung der Stromerzeugung (65442 B). Ernst Blau. 2000 w. E u M—Oct. 17, 1915. Results obtained in reducing cost of electricity by use of exhaust and low-pressure steam.

See also MARINE AND NAVAL ENGINEERING.

TRANSPORTING AND CONVEYING

Derricks

See CIVIL ENGINEERING, *Construction.*

Elevators

Electric Elevators (65500). C. B. Garrison. Ills. 2500 w. Natl Engr—Nov., 1915. Maintenance, inspection, tests.

Material Handling

Labor Saving by the Use of Cranes (65992 A). Robert L. Streeter. Ills. 5000 w. Engng Mag—Dec., 1915. Second article of series, describing the mechanism and operation of cranes.

MISCELLANY

Acetylene

The Explosibility of Acetylene (65883 N). George A. Burrell and G. G. Oberfell. 2000 w. U S Bureau of Mines—Tech paper 112. Experiments on limits of complete propagation of flame.

Glass Industry

The Relation of Chemistry and Mechanical Manipulation to the Evolution of the Glass Industry (65522). Robert L. Frink. N. Y. address before Nat. Exp. of Chem. Ind. 3500 w. Met & Chem Engng—Nov. 1, 1915.

MINING AND METALLURGY

BASE METALLURGY

Copper Smelteries

Copper Queen Reduction Works, Arizona (65593). C. A. Tupper. Ills. 2000 w. Min & Engng Wld—Nov. 6, 1915. Improvements.

Smelting at Panulcillo, Chile (65716). Ills. 1800 w. Eng & Min Jour—Nov. 13, 1915. Describes smelting operations of Chile Copper Co.

Pulverized Fuel

Pulverized Coal for Copper Smelting (65592). N. L. Warford. Ills. 700 w. Min & Engng Wld—Nov. 6, 1915. Plant of Anaconda Copper Mining Co.

Smelter Smoke

Report of the Selby Smelter Commission (65547 N). Ills. J. A. Holmes, Edward C. Franklin, and Ralph A. Gould. 520 pp. U S Bureau of Mines—Bul. 98. Smelter smoke problems are investigated.

Zinc Oxide

Zinc Oxide from Lead Blast Furnace Slag, as in Operation at South Chicago (65520). H. B. Pulsifer. Ills. 1200 w. Met & Chem Engng—Nov. 1, 1915. Recovery from slag dumps by B. F. Hedges and R. D. Divine.

COAL AND COKE

Byproduct Coke-Ovens

Coke-Ovens with Tap Heat (65700 A). O. Simmersbach. From an article in *Stahl und Eisen.* Ills. 1500 w. Ir & Coal Trds Rev—Oct. 29, 1915. Details of the Collin coke oven.

Byproducts

Coal Gas Residuals (65649). Fred H. Wagner. Ills. 5500 w. Sci Am Sup—Nov. 13, 1915. Valuable by-products and methods of saving them.

Destillationsuntersuchungen deutscher Steinkohlen (65980 B). Oskar Simmersbach and Max Ziem. Ills. 2400 w. Research work on distillation products obtainable from various German hard coals.

Coal Analysis

Making a Chemist's Balance (65377). F. W. Salmon. Ills. 1500 w. Power—Nov. 2, 1915. For coal analysis.

Determination of Nitrogen in Coal (65851 N). Arno C. Fieldner and Carl A. Taylor. 18 pp. U S Bureau of Mines—Tech paper 64. A comparison of various modifications of the Kjeldahl method with the Dumas method.

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Coal Storage
Insuring the Coal Supply (65559). Henry J. Edsall. Ills. 5000 w. Coal Age—Nov. 6, 1915. Methods of stocking and precautions.

Coke
Gewinnung und Aussenhandel Deutschlands und Grossbritanniens an Koks und sogenannten Nebenerzeugnissen (65450 B). Ernst Jüngst. 4000 w. Glck—Oct. 16, 1915. Statistical comparison of coke industry in Germany and Great Britain.

Explosions
Experiments with Coal Dust at the Derne Gallery (65697 A). From *Glückauf*. 4000 w. Col Guard—Oct. 29, 1915. Experiments and results.

India
Coal Mining in India in 1914 (65698 A). 2500 w. Col Guard—Oct. 29, 1915. Information from report of G. F. Adams.

Lancashire
Problems of the South Lancashire Coal Field (65921 A). Dr. George Hickling. Ills. 7000 w. Col Guard—Nov. 12, 1915. Serial, 1st. part. Address to Manchester Geol. & Min. Soc. Structure, disturbances, influence on concealed outcrops.

Mine Fires
Treating a Gob Fire in Northumberland (65699 A). Ills. 1200 w. Col Guard—Oct. 29, 1915. Methods used to combat it.

Mine Plants
Modern Mine-Plant Design (65558). M. L. Hyde. Ills. 4000 w. Coal Age—Nov. 6, 1915. Serial, 1st. part. Arrangement of surface works at coal mines.

Mining Methods
Output of Coal and the Use of Electricity in Mines (65626 A). 1800 w. Elec Rev, Lond—Oct. 22, 1915. Machine mining and other uses.
See also *Mine Operation.*

Philippines
The Persistence of Philippine Coal Beds (65838 N). Wallace E. Pratt. Ills. 3500 w. Philippine Jour of Sci—Sept., 1915. Quality, development, and general information.

Rhode Island
Rhode Island Coal (65655 N). George H. Ashley. Ills. & map. 55 pp. U S Geol Surv—Bul. 615. The coal, its use, and its mining.

GEOLOGY

Bingham
The Disseminated Copper Ores of Bingham Canyon, Utah (65530 D). J. J. Beeson. Ills. 9500 w. Am Inst of Min Engrs, Bul—Nov., 1915. Country rock and alterations, and processes of secondary enrichment.

Philippines
Geologic Reconnaissance in Caramoan Peninsula, Camarines Province (65839 N). Wallace E. Pratt. Ills. 17 pp. Philippine Jour of Sci—Sept., 1915. Geography and general and economic geology.

Notes on a Geologic Reconnaissance of Mountain Province, Luzon, P. I. (65833 N). Warren D. Smith. Ills. 30 pp. Philippine Jour of Sci—May, 1915. Geography, geology, and general information.

Notes on the Geology of Tanay (65834 N). Warren D. Smith. Ills. 18 pp. Philippine Jour of Sci—May, 1915. Geology, and general information.

Polished Sections
See metallography under MECHANICAL ENGINEERING, *Measurement.*

War Geology
Kriegsgeologie und ihre Beziehungen zur montanistischen Praxis (65408 B). Friedrich König. 3500 w. Mn Rnd—Sept. 16, 1915. Explanation of new science of "war geology" and its relation to mining.

Witwatersrand
Conditions of Deposition of the Witwatersrand System (65995 A). E. T. Mellor. Ills. 8 pp. Min Mag—Nov., 1915. From advanced proofs or article read before Geol. Soc. of South Af. Conclusions from official geological survey.

IRON AND STEEL

Blast-Furnace Gas
Utilization of Blast Furnace Gas (65682). A. N. Diehl. Read at Cleveland meeting of Iron & Steel Inst. 2500 w. Ir Trd Rev—Nov. 11, 1915. Serial, 1st. part. Modern methods.

Blast-Furnace Practice
Ueber die Zumischung von Sauerstoff zum Gebläsewind der Hochöfen (65424 B). Hermann Blome. Ills. 2400 w. St u E—Oct. 7, 1915. Results obtained by introducing oxygen into the blast-furnace blast.

Chile
Das Eisenerzvorkommen von Tofo bei Coquimbo in Chile (65489 B). B. Simmersbach. 2200 w. Gla Ann—Nov. 1, 1915. General description of the Tofo iron mines in Chile, owned by Bethlehem.

Electrometallurgy
Steel Making in the Electric Furnace (65942 A). James H. Gray. 1800 w. Ir Age—Nov. 25, 1915. From a paper read at Int. Engng. Cong. Growth of the industry; savings effected.

Electrothermic Smelting of Iron Ores in Sweden (65842 N). Alfred Stansfield. Ills. 59 pp. Canada Dept of Mines—No. 344. Economic commercial operation of the iron-smelting furnaces.

Ingots
Segregation and Sponginess in Ladle Test Ingots (65887 N). Robert W. Hunt Co. Ills. 1400 w. Am Ry Engng Assn, Bul—Sept., 1915. Results of investigations.

Italy
La sidérurgie Italienne (65984 B). Ills. 2000 w. La Nat—Nov. 13, 1915. Brief review of the development of the steel industry in Italy.

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Philippines

Iron Ore on Calamboyanga Island, Mambulao Camarines (65840 N). Wallace E. Pratt. Maps. 2500 w. Philippine Jour of Sci—Sept., 1915. History, geology, character, and quantity.

Iron Ore in Surigao Province (65841 N). Wallace E. Pratt and Victor E. Lednicky. Ills. 3500 w. Philippine Jour of Sci—Sept., 1915. Character, quantity, and commercial possibilities.

Publicity

See same heading under INDUSTRIAL ECONOMY, *Management.*

Slag-Crushing

See Crushing under *Ore Dressing.*

Statistics

Annual Statistical Report (65472 N). 118 pp. Am Iron & Steel Inst—1915. Imports and production, 1914.

MINE OPERATION

Costs

What Constitutes the Cheapest Mining (65728). William H. Storms. 2200 w. Min & Engng Wld—Nov. 13, 1915. Open cuts under favorable conditions.

Electric Power

The Development of Electricity in the Scottish Mining Industry (65642 A). A. B. Muirhead. 3000 w. Ir & Coal Trds Rev—Oct. 22, 1915. Presidential address before W of Scotland Branch of Assn. of Min. Elec. Engrs.

Practical Points in Connection with the Use of Electricity in Mines. (65701 A). Ralph R. Smith. Read before the Nat. Assn. of Col. Mgrs. 4000 w. Ir & Coal Trds Rev—Oct. 29, 1915. Instructions.

Grouting

A Summary of Experience with Grouting in Sinking Wet Shafts (65501). 1000 w. Engng & Con—Nov. 3, 1915. Lessons taught by examples.

Haulage

Compressed Air Haulage in Scotland (65922 A). Diagrams. 600 w. Col Guard—Nov. 12, 1915. Direct rope and main and tail rope with compressed air as motive power.

Hoisting

Förderkorbbesschickungsvorrichtungen mit elektrischen Antrieb (65448 B). Wintermeyer. Ills. 4000 w. Mont Rund —Oct. 16, 1915. Methods of applying electric drive to loading cars on cages.

The Silver Hill Underground Hoisting Station (65560). James Humes. Ills. 3000 w. Eng & Min Jour—Nov. 6, 1915. Unusually large underground hoist and compressor station; electrically driven.

Illumination

Illumination of Mines (65531 D). Robert P. Burrows. Ills. 2000 w. Am Inst of Min Engrs, Bul—Nov., 1915. Facts relating to illumination problems.

Power Plants

The Rotary in Mine Work (65320). C. M. Means. 1200 w. Coal Age—Oct. 30, 1915. Advantages over the motor-generator set.

Pumping

Pumping at the Commonwealth Mine, Arizona (65939). Edgar A. Collins. Diagrams. 1500 w. Min & Sci Pr—Nov. 20, 1915. Details of a large pumping problem in the solution of which a steel bulkhead door was set in the cross-cut.

Rock Drilling

How to Choose Rock Drills (65329). J. R. McFarland. 6000 w. Eng & Min Jour —Oct. 30, 1915. How tests should be made.

Hammer-Drilling in Colorado (65393). E. G. Snedaker. Ills. 2500 w. Min & Sci Pr—Oct. 30, 1915. Novel applications.

Sampling

Sampling Low-Grade Ore on a Large Scale (65790). Downie D. Muir, Jr. Ills. 3500 w. Min & Sci Pr—Nov. 13, 1915. Methods used in Alaska.

Shafts

Collapse and Recovery of Central Incline Shaft, Bantjes Consolidated Mines Limited (65930 A). Percy Cazalet and W. W. Lawrie. From *Jour. S. African Inst. of Engrs.* Ills. 2000 w. Col Guard —Nov. 5, 1915. Details of the work.

Stoping

Notes on Shrinkage Stoping (66004). E. H. Dickenson and H. J. Volkes. Ills. 2000 w. Eng & Min Jour—Nov. 27, 1915. Details of methods.

Surveying

A New Method of Putting in Survey Stations (65861). H. C. Austin. Ills. 1500 w. Coal Age—Nov. 20, 1915. Sight stations less liable to damage if placed in the roof.

Timbering

Calculation of Mine Gangway Timbers (65862). A. G. Morlock. 1400 w. Coal Age—Nov. 20, 1915. Determining sizes of different kinds of timber or steel.

Ventilation

Ueber die Temperatur der Erdrinde und ihre Beziehungen zum Luftdruck und zur Luftdichte (65449 B). Chr. Mezger. 5000 w. Glck—Oct. 16, 1915. Investigations into underground temperatures and their bearing on the dynamics of air movement.

MINES AND DISTRICTS

See also *Geology.*

Arizona

Mining in Arizona (65791). Charles F. Willis. Map. 1600 w. Min & Sci Pr —Nov. 13, 1915. Conditions during the past month.

Beaver Lake

The Beaver Lake District, Saskatchewan and Manitoba (65551). William McInnes. Extracts from Mem. No. 30. Maps. 4000 w. Can Min Jour—Nov. 1, 1915. Report of survey of "The Basins of Nelson and Churchill Rivers."

Brazil

The Mineral Wealth of Brazil (65669 A). 2500 w. Engng—Oct. 29, 1915. Ore deposits and their development.

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Broad Pass

The Broad Pass Region, Alaska (65797 N). Fred H. Moffit. Ills. & Maps. 70 pp. U S Geol Surv—Bul. 608. Geologic and topographic features of this pass through which a railway route is planned.

California

Gold, Silver, Copper, Lead, and Zinc in California and Oregon in 1914 (65757 N). Charles G. Yale. 60 pp. U S Geol Surv, I: 13—Oct. 30, 1915. Production.

Ellamar

The Ellamar District, Alaska (65796 N). S. R. Capps and B. L. Johnson. Maps & Ills. 115 pp. U S Geol Surv—Bul 605. Detailed study of the geology and ores.

Hungary

Bergbau und Hüttenwesen Ungarns im Jahre 1913 (65425 B). D. A. Zsigmondy. Ills. 3000 w. Glck—Oct. 9, 1915. General review of Hungary's mining and metallurgy in 1913.

Malaya

Mineralization in Malaya (65429 A). William R. Jones. Ills. 4000 w. Min Mag—Oct., 1915. Serial, 1st. part. Particularly tin lodes.

Mining in Trengganu (65996 A). Henry Brelich. Ills. 4 pp. Min Mag—Nov., 1915. Tin, tungsten and other minerals on the east coast of the peninsula.

New Zealand

Mines Statement (65496 N). W. D. S. MacDonald. Ills. 110 pp. Report for 1914 by minister of mines on production, labor, etc.

Oregon

See California.

Philippines

The Mineral Resources of the Philippine Islands for the year 1914 (65654 N). Ills. 35 pp. Philippine Bureau of Sci—1915. Eight short articles. Five by Wallace E. Pratt. Three by Victor E. Lednicky. Statistics, production, and information.

Turkey

Minerals of Asiatic Turkey (65328). Map. 2500 w. Eng & Min Jour—Oct. 30, 1915. Important mineral region. Copper, mercury and antimony.

Waihi

The Geology of the Waihi Grand Junction Mine (65905 N). Arthur Jarman. 4500 w. Inst of Min & Met, Bul. 134—Nov. 11, 1915. Discussion by H. Foster Bain and others.

Willow Creek

The Willow Creek District, Alaska (65752 N). Stephen R. Capps. Ills. & Maps. 77 pp. U S Geol Surv—Bul. 607. Information concerning this gold-bearing district. Geography, geology, mineral resources, etc.

Yukon

Mining in the Yukon (65550). J. B. Tyrrell. Ills. 6000 w. Can Min Jour—Nov. 1, 1915. Methods, production, costs.

MINOR MINERALS

Antimony

Electrolytic Antimony Refining (65741 A). Anson G. Betts. 4000 w. Met & Chem Engng—Nov. 15, 1915. Read before Am. Elec-Chem Soc, San Francisco. Experiments and results.

Asbestos

Chysotile-Asbestos (65936). F. H. Mason. 1200 w. Min & Sci Pr—Nov. 20, 1915. Canada contributes about 85 per cent of the world's production of asbestos of this variety.

Magnesite

The Production of Magnesite in 1914 (65756 N). Charles G. Yale and Hoyt S. Gale. Map. 18 pp. U S Geol Surv, II: 30—Oct. 28, 1915. Character, production, uses, etc.

Molybdenum

Molybdenite in the Mount Perry District (65735 N). Lionel C. Ball. Ills. 2500 w. Queens Gov Min Jour—Oct. 15, 1915. A recent discovery.

Notes on the Geology of the "Molly" Molybdenite Mine, Lost Creek, Nelson Mining Division, B. C. (65799 N). Charles W. Drysdale. 2500 w. Can Min Inst, Bul—Nov., 1915. Uses of molybdenum; Canadian occurrences; description of mine named.

Potash

Potash from Wood and Plant Ashes (65739 A). Harlow Bradley. 5000 w. Met & Chem Engng—Nov. 15, 1915. History and manufacture, possible improvements in method, uses, etc.

Potash in Certain Copper and Gold Ores (65843 N). B. S. Butler. With a note on muscovite by George Steiger. 2200 w. U S Geol Surv, Bul 620-J—Nov. 15, 1915. Analyses from different districts showing the potash content.

Quicksilver

Das Zinnobervorkommen von Idria in Krain unter Berücksichtigung neuerer Aufschlüsse (65479 B). A. Pilz. Ills. 6000 w. Glck—Oct. 30, 1915. Serial, 1st. part. New developments in the quicksilver deposits of Idria; chiefly geology.

Radioactive Substances

Determinación del contenido radioactivo de las sales en las aguas del Atlántico y del Pacífico entre Montevideo y el Callao (65486 N). Urbano Mialock. Ills. 9 pp. Soc Cien Arg An—May-June, 1915. Study of radioactivity of salt from sea water around southern South America.

Tin

Tin and Tungsten in the West of England (65431 A). J. H. Collins. 2400 w. Min Mag—Oct., 1915. History and situation.

The Physical Condition of Cassiterite in Cornish Mill Products (65906 N). 1800 w. Inst of Min & Met, Bul. 134—Nov. 11, 1915. Continued discussion of J. J. Beringer's paper.

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See also Tin.

OIL AND GAS

Drilling

The Evolution of Drilling Rigs (65532 D). R. B. Woodworth. Ills. 15500 w. Am Inst of Min Engrs, Bul—Nov., 1915. Development of the application of steel and other data.

Gasoline

Manufacture of Gasoline by the Action of Aluminum Chloride on High Boiling Petroleum (65616). A. M. McAfee. Read before Am. Inst. of Chem. Engrs., at San Francisco. 3500 w. Am Gas Lgt Jour—Nov., 8, 1915. The problem and its solution.

Philippines

On the Occurrence of Petroleum in the Province of Cebu (65837 N). Wallace E. Pratt. Ills. 1800 w. Philippine Jour of Sci—July, 1915. Quality of oil obtained and locations known.

Petroleum and Residual Bitumens in Leyte (65836 N). Wallace E. Pratt. Ills. 38 pp. Philippine Jour of Sci—July, 1915. Occurrence, character, and suggestions for exploration.

Reservoirs

Concrete-Lined Oil-Storage Reservoirs in California: Construction Methods and Cost Data (66021 D). 500 w. Am Soc Civ Engrs, Pro—Nov., 1915. Discussion of E. D. Cole's paper.

World Production

Le Petrole et la Guerre (65444 B). A. Guiselin. 21 pp. Soc Ing Civ Fr, Pro-Ver—Sept. 24, 1915. Relation of oil production to the current war.

ORE DRESSING

Coeur d'Alenes

Metallurgy in the Coeur d'Alenes (65868). Herbert A. Megraw. Ills. 3500 w. Eng & Min Jour—Nov. 20, 1915. The ores of this Idaho district are a complex mixture of argentiferous lead and zinc. Flotation of value.

Crushing

Brechanlagen für Hochofenschlacke (65459 B). A. Mann. Ills. 2000 w. St u E—Oct. 21, 1915. New plant for crushing blast-furnace slag.

Flotation

Flotation of Joplin-Galena Slimes (65740 A). George Belchic and Glenn L. Allen. 700 w. Met & Chem Engng—Nov. 15, 1915. Flotation tests.

Cyanide Treatment of Flotation Concentrate (65938). Charles Butters and J. E. Clennell. 5000 w. Min & Sci Pr—Nov. 20, 1915. Recent tests on gold-silver ore of the San Sabastian mine, Salvador.

A new Flotation Experiment (66035). 300 w. Eng & Min Jour—Nov. 27, 1915. Experiment plant at Ohio Copper; Field process; leaching and floating.

Sampling Plant

See Sampling under Mine Operation.

PLACER MINING

Drift Mining

Winter Mining at Fairbanks (65327). Hubert I. Ellis. Ills. 3500 w. Eng & Min Jour—Oct. 30, 1915. Methods.

PRECIOUS METALLURGY

Cyanide Plants

Building the Tough-Oakes Mill (66003). John A. Baker. Ills. 4000 w. Eng & Min Jour—Nov. 27, 1915. Serial, 1st. part. Rapid development at Kirkland Lake, Ont.

Trojan Ore and Milling Practice (65643). Ills. 2500 w. Min & Sci Pr—Nov. 6, 1915. Cyanidation in the Black Hills.

Cyanide Practice

Cyanide Consumption on the Witwatersrand (65769 N). H. A. White. 4800 w. Chem, Met, & Min Soc of S Africa, Jour—Sept., 1915. Experiments made to ascertain possibilities of effecting saving.

The Determination of Mercury in Cyanide Solution and Precipitate (65391). W. J. Sharwood. 1800 w. Min & Sci Pr—Oct. 30, 1915. Details of methods.

The Prevention of Hydrolysis in Cyanide Solutions (65770 N). H. M. Leslie. Also discussion. 8500 w. Chem, Met & Min Soc of S Africa, Jour—Sept., 1915. Experimental study, with results.

The Electrolytic Precipitation of Gold, Silver and Copper from Cyanide Solutions (65523). G. H. Clevenger. Read before Am. Elec-Chem. Soc. Ills. 4000 w. Met & Chem Engng—Nov. 1, 1915. Serial, 1st part. Details of plants.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Interlocking

Testing a New Interlocking Plant (65581). 1800 w. Sig Engr—Nov., 1915. Outlines points to be noted and methods recommended.

Electric Interlockings in Australia (65579). C. G. Pilkington. Ills. 3000 w. Sig Engr—Nov., 1915. Details of first installation.

Electric Interlocking at Adelaide, South Australia (65853). C. G. Pilkington. Ills. 2000 w. Ry Age Gaz—Nov. 19, 1915. Speed signaling and three-position upper quadrant indications.

Reclaiming

Reclaiming Signal Material from Scrap (65644 A). Ills. 1200 w. Ry Engng & Main of Way—Nov., 1915. Possibilities of repairing.

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Signaling Installations

A. C. L. Signaling Between Richmond and Pleasant Hill (65582). A. W. Stewart. Ills. 1000 w. Sig Engr—Nov., 1915. Automatic block signaling.

The Signaling of the Queens Park Extension (65665 A). Ills. 1800 w. Elect'n, Lond—Oct. 29, 1915. Latest example of signaling on a tube railway.

A New Cab Signal and Automatic Stop (65583). Ills. 3000 w. Sig Engr—Nov., 1915. Installation on Western Pacific uses magnetic induction and eliminates roadside signals.

Signaling Practice

Development of Main-Line Signaling on Railways (65668 A). W. C. Acfield. Ills. 4500 w. Engng—Oct. 29, 1915. Serial, 1st. part. Read before Birmingham Sec. of Inst. of Elec. Engrs. Outlines the various systems.

Train Control

Cab Signals and Train Control (65471 B). Ills. 2000 w. Ry Engr—Nov., 1915. Description of Raven system.

MOTIVE POWER AND EQUIPMENT

Air Brakes

Broken Air Pipes with E. T. Equipment (65389 A). 2200 w. Ry & Loc Engng—Nov., 1915. Temporary repairs.

Motor Driven Air Compsessors (65388 A). Ills. 700 w. Ry & Loc Engng—Nov., 1915. Describes types.

Calibration Charts

Calibration Charts for Vanderbilt Tenders (65585 A). Towson Price. 1000 w. Ry Age Gaz (Mech Ed)—Nov., 1915. Method of calculation.

Electric Locomotives

Three - Thousand - Volt Direct - Current Electric Locomotives (65509). Ills. 1000 w. Sci Am—Nov. 6, 1915. Passenger locomotive of the C., M., & St. P. Ry.

Electrification

Pennsylvania R. R. Electrifies Philadelphia District (65688). Ills. 3000 w. Eng News—Nov. 11, 1915. Overhead construction, signal system and rolling stock.

Pennsylvania Inaugurates Electric Service in Philadelphia (65718). Ills. 4000 w. Eng Rec—Nov. 13, 1915.

Electrification of the Pennsylvania at Philadelphia (65707). Ills. 4500 w. Ry Age Gaz—Nov. 12, 1915.

Victorian Railways Newport Power House (65622 N). Ills. 2000 w. Comnwlth Engr—Oct., 1915. Progress of the electrification scheme.

Engine Failures

Engine Failures, Their Causes and Cure (65587 A). J. E. Anderson. 1800 w. Ry Age Gaz (Mech Ed)—Nov., 1915. Things conducive to engine failures.

Freight Cars

Freight Car Rehabilitation, Southern Railway (65573). Ills. 800 w. Ry Rev—Nov. 6, 1915. Adapting light capacity cars to resist severe shocks.

Fuel

The Fuel Department—A Constructive Criticism (65854). L. G. Plant. Read before New England Ry. Club. 3500 w. Ry Age Gaz—Nov. 19, 1915. Factors upon which success depends.

Internal-Combustion Locomotives

An Internal-Combustion Locomotive for Working on Steep Inclines (65915 A). Ills. 1800 w. Ry Gaz, Lond—Nov. 12, 1915. Details of the Fell Triple-rail system.

Locomotive Design

Mikado Versus Consolidation Locomotives (65852). N. D. Ballantine. 3000 w. Ry Age Gaz—Nov. 19, 1915. Economical distribution of power from a net revenue standpoint.

Gegengewichtsberechnung einer Dreizylinder-Lokomotive mit um 120° versetzen Kurbeln (65439 B). E. Najork. Ills. 1500 w. Gla Ann—Oct. 15, 1915. Method of calculating position and weight of counterweights for three-cylinder, 120-degree-crank locomotive.

Locomotive Equipment

Locomotives Ordered in America for Foreign Countries (65955). Ills. 1500 w. Ry Age Gaz—Nov. 26, 1915. Engines built for Greece, Serbia, Russia, and Belgium.

New Six-Wheeled Type of Switching Locomotives for the Chicago Great Western Railroad, and the Public Belt Railroad Commission of New Orleans (65386A). Ills. 800 w. Ry & Loc Engng—Nov., 1915. Detailed descriptions.

First 4-8-2 Locomotives in Canada (65584 A). W. H. Winterrowd. Ills. 2500 w. Ry Age Gaz (Mech Ed)—Nov., 1915. Engine trucks equalized with driving system.

Eight-Wheels Coupled Engines on British Railways (65923 A). E. L. Ahrons. 3000 w. Engr, Lond—Nov. 12, 1915. Changed conditions, with description of recent engines.

New 2-6-0 Type Locomotive for the Glasgow South-Western Railway (65776 A). Ills. 250 w. Ry Gaz, Lond—Nov. 5, 1915. Detailed description.

Locomotive Operation

The Value of a Freight Locomotive from a Transportation Standpoint (65653 A). N. D. Ballantine. Also discussion. 33 pp. W Ry Club, Pro—April 20, 1915. Analytical study.

Motor Cars

The Value of Motor Cars on Railroad Systems (65751 A). W. R. McKeen. Also discussion. 10800 w. N Y R R Club, Pro—Oct. 15, 1915. On branch lines.

Shops

North Billerica Locomotive Machine Shop—Boston and Maine Railroad (66030 A). Ills. 6000 w. Ry Mas Mech—Nov., 1915. Details showing modern tendencies in construction of railroad shops.

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Test Cars

New United States Bureau of Standards' Test Car, Built by the Pennsylvania Railroad Company (65387 A). Ills. 1200 w. Ry & Loc Engng—Nov., 1915. Test Weight Car No. 2 is described.

Valve Gears

Verbesserte Schwingensteuerung für Lokomotiven, Patent Lindner (65981 B). R. Klien. Ills. 800 w. Schw Bau—Nov. 6, 1915. New locomitive valve gear, Lindner patent.

PERMANENT WAY AND BUILDINGS

Grade Separation

Difficult Grade Crossing Elimination in Albany, N. Y. (65859). Ills. 2200 w. Ry Age Gaz—Nov. 19, 1915. Measures adopted.

Track Elevation on the Nickel Plate Railroad at Chicago (65542). Ills. 1600 w. Eng News—Nov. 4, 1915. Complicated grade-crossing work.

Elimination of the Tower Grove Crossings, St. Louis, Mo. (65761 A). S. L. Wonson. Ills. 3500 w. Assn Engng Socs, Jour—Oct., 1915. Conditions, plans, cost, conduct of work, etc.

The Adjustment of the Consequential Damages at the Tower Grove Crossings (65762 A). L. R. Bowen. 1500 w. Assn Engng Socs, Jour—Oct., 1915. Method of estimating damages and awards.

Rails

Influence on Rails of Method of Blooming (65888 N). M. H. Wickhorst. Ills. 23 pp. Am Ry Engng Assn, Bul—Sept., 1915. Tests, particularly transverse ductility of base of rail.

Rail Failure Statistics for 1915 (65886 N). M. H. Wickhorst. 23 pp. Am Ry Engng Assn, Bul—Sept., 1915. Statistics furnished by railroads of the United States.

Transverse Fissures the Result of Rail Gagging (65952). P. H. Dudley. Ills. 2500 w. Ry Age Gaz—Nov. 26, 1915. Types caused by local application of gag to base and head of rail respectively.

Smoke

Experience with Engine-House Smoke Washer (65545). M. D. Franey. Ills. 1200 w. Eng News— Nov. 4, 1915. Read at Cincinnati. At Englewood terminal, Chicago.

Stations

The Union Station Ordinance, Cleveland (66014 A). R. O. Rote. 4500 w. Cleveland Engng Soc, Jour—Nov., 1915. Provision of ordinance in regard to lands for extension and improvements.

Terminals

The Cleveland & Youngstown Freight Terminal Ordinance (66016 A). W. E. Pease. Ills. 4800 w. Cleveland Engng Soc, Jour—Nov., 1915. Outlines the project and its aim. Discussion.

New Engine Terminal for the O. W. R. R. & N. Co., Spokane, Wash. (65574). Ills. 1000 w. Ry Rev—Nov. 6, 1915. Details.

Track Scales

Adjusting Railroad Track Scales (65858). Diagrams. 1200 w. Ry Age Gaz—Nov. 19, 1915. Advantages of the off-section loading.

Track Tools

The Proper Repair of Tools for Track Maintenance (65856). M. E. Carroll. Ills. 2000 w. Ry Age Gaz—Nov. 19, 1915. Work should be done under adequate administration.

Water Tanks

Railway Roadside Water Tank for Locomotive Supply (65857). Abstract of report to Am. Ry. Bridge & Building Assn. 4000 w. Ry Age Gaz—Nov. 19, 1915. Details of construction and maintenance with comparative costs.

ROADS AND PROJECTS

Africa

De ontwikkeling van het spoorwegnet in Centraal-Afrika (65976 B). L. Kooyker. Ills. 3500 w. Ingenieur—Oct. 30, 1915. Survey of progress in railroad building in Central Africa.

England

Les chemins de fer en Angleterre (65468 B). J. Carlier and H. Dedroog. Ills. 5000 w. Gen Civ—Oct. 30, 1915. Serial, 1st. part. History and general description of English railways.

Furka Line

The Furka Railway and Furka Tunnel (65783 A). 1200 w. Engng—Nov. 5, 1915. Details of new line in Switzerland.

Great Western Ry.

Great Western Railway Departmental Organization (65775 A). Maps. 3500 w. Ry Gaz, Lond—Nov. 5, 1915. Reproduction from a pamphlet recently issued, with comments.

Holland

Mededeeling over den aanleg der spoorwegen van de Hollandsche Electrische Spoorweg-Maatschappij in de Haarlemmermeer en omgeving (65410 B). J. W. Th. Van Oyen. 2500 w. Ingenieur—Oct. 9, 1915. Outline of plan by the Holland Electric Railway for building in the vicinity of the Haarlem polder.

Lackawanna

Completing the Summit Cut-Off of the Lackawanna (65317). Ills. 1000 w. Ry Age Gaz—Oct. 29, 1915. Finishing work on the Nicholson viaduct.

Mexican Railway

The Mexican Railway; 1873 and 1915 (65946). Ills. 2300 w. Eng News—Nov. 25, 1915. Difficulties of the original location made by American engineers. Special locomotives for operating 4 per cent grades.

TRAFFIC

Car Inspectors

The Making of Good Car Inspectors (65586 A). 4000 w. Ry Age Gaz (Mech Ed)—Nov., 1915. Serial, 1st part. Papers on training and development. First prize paper, A. M. Orr.

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Freight Handling

The Economical Handing of L. C. L. Freight Traffic (65953). 6000 w. Ry Age Gaz—Nov. 26, 1915. Two prize papers. I. How the Operation of One Local Freight Station Was Improved. C. B. Anderson. II. Important Principles in the Handling of L. C. L. Freight. C. G. Johnson.

Train Loading

Scientific Train Loading; Tonnage Rating (65575). O. S. Beyer, Jr. Before Trav. Engrs.' Assn. 3500 w. Ry Rev—Nov. 6, 1915. Factors in train haul problems.

Women Employees

The Efficiency of French Women as Railway Workers (65855). Walter S. Hiatt. Ills. 2500 w. Ry Age Gaz—Nov. 19, 1915. Commendation.

MISCELLANY

Relations

Report of Committee on Relations Between Railroads (65956). 3000 w. Ry Age Gaz—Nov. 26, 1915. Report to the American Railway Association.

Statistics

Comparative Statistics of the World's Railways (65316). 3500 w. Ry Age Gaz—Oct. 29, 1915.

STREET AND ELECTRIC RAILWAYS

Car Lighting

Maintenance of Electric Car Lighting Equipment (66026). E. S. M. Macnab. 2200 w. Ry Rev—Nov. 27, 1915. Extract from paper read before the Can. Ry. Club, giving Can. Pacific Ry. practice in inspection and maintenance.

Cars

Electrical and Mechanical Details of the Bay State Car (66032). Ills. 3500 w. Elec Ry Jour—Nov. 27, 1915.

Neue Decksitz-Motorwagen der Wiener städtischen Strassenbahnen (65476 B). Ludwig Spängler. Ills. 2000 w. E K u B—Oct. 24, 1915. Description of new two-deck car for Vienna.

Elevated Roads

Ornamental Concrete Elevated Railway, New York City (65684). Maurice E. Griest. Ills. 3900 w. Eng News—Nov. 11, 1915. Vaulted arch construction on Queens Boulevard, N. Y.

See also Elevated Railroad under CIVIL ENGINEERING, *Bridges*.

Electrolysis

Effects of Electrolysis on Engineering Structures (65919 A). Albert F. Ganz. Abstract of paper read at Int. Engng. Cong. 5500 w. Electric, Lond—Nov. 12, 1915. Caused by stray currents from electric railways; means of averting.

Interurban

Seven Years of Operating Experience of a Single-Phase Interurban Railway (65590). Ills. 2500 w. Elec Ry Jour—Nov. 6, 1915. Results on the Chicago, Lake Shore, & South Bend Ry.

Maintenance

Graphics in Maintenance Work (65591). Ills. 1500 w. Elec Ry Jour—Nov. 6, 1915. Examples of graphical records in electric railway practice.

New York

Development of New York's Rapid Transit System Resulting in Dual Contracts (65569). Map. 2500 w. Eng Rec—Nov. 6, 1915. Advances made in facilities for handling heavy traffic.

Paris

Paris Inter-Urban Traffic and the War (65782 A). 2000 w. Engng—Nov. 5, 1915. Report of changed conditions due to war influence.

Portland, Ore.

Generating and Distributing System of Portland Railway, Light and Power Company (65732). R. R. Robley. Ills. 3000 w. Elec Trac—Nov., 1915. Descriptive.

Power Plants

A Railway Power Plant Rebuilt Without Interfering with Operation (65363). Ills. 2500 w. Elec Ry Jour—Oct. 30, 1915. At Springfield, O.

Rail Bonding

Gas-Weld Rail Bonding (66034). J. Rowland Brown. Read before the Ill. Elec. Assn. Ills. 2000 w. Elec Ry Jour—Nov. 27, 1915. Welding equipment and advantages of the process.

Shops

Cleveland Railway Occupies New Repair Shops (65882). Ills. 3500 w. Elec Ry Jour—Nov. 20, 1915. Outline of operation and description of special equipment.

Snow

Fighting the Storm King in Montreal (65731). A. Gaboury. Ills. 3000 w. Elec Trac—Nov., 1915. Methods and equipment for snow removal.

Subways

The East 55th Street Subway Ordinance (66015 A). Bernard L. Green. Also discussion. 3000 w. Cleveland Engng Soc, Jour—Nov., 1915. Proposed subway in Cleveland, O., from L. Erie to points in the upper Cuyahoga Valley, and to provide extensive railway yards.

I. The Harlem River Four-Track Subway Tunnel. Olaf Hoff. II. Detail and Fabrication of Harlem River Tubes. Thomas Duckforth (65748 B). Ills. Discussions of both papers. 67 pp. Engrs' Soc of W Penn, Pro—Oct., 1915. Sections of the Lexington ave subway, N. Y. City.

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In the list below, *w* indicates a weekly publication; *b-w*, a bi-weekly; *m*, a monthly; *b-m*, a bi-monthly; *t-m*, a tri-monthly; *s-m*, a semi-monthly; *qr.*, a quarterly; *s-q*, a semi-quarterly, etc.

American Electrochemical Society. South Bethlehem.
American Foundrymen's Association. Cleveland.
American Gas Light Journal. *w*. New York.
American Inst. of Architects. *yr*. New York.
Amer. Jour. of Public Health. *m*. New York.
Amer. Jour. of Science. *m*. New Haven.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. d Arch Ital. *s-m*. Rome.
Applied Science. *m*. Toronto.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architecture and Building. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automobil Rundschau. *s-m*. Berlin.

Beton und Eisen. *s-m*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. New York.
Brickbuilder. *m*. Boston.
Bull. Am. Inst. Mining Engrs. *m*. New York.
Bull. Am. Iron & Steel Inst. *m*. New York.
Bull. Am. Ry. Engng. Assn. *m*. Chicago.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bull. Can. Min. Inst. *m*. Montreal.
Bull. Soc. Int. d'Électriciens. *m*. Paris.
Bulletin of the Univ. of Wis. Madison.
Bull. Int. Railway Congress. *m*. Brussels.
Bull. Univ. of Illinois. Urbana, Ill.
Bureau of Mines. Washington.
Bureau of Standards. Washington.

Canadian Engineer. *w*. Toronto and Montreal.
Canadian Mining Journal. *b-w*. Toronto.
Chem. Met. Min. Soc. S. Af. *m*. Johannesburg.
Coal Age. *w*. New York.
Colliery Engineer. *m*. Scranton.
Colliery Guardian. *w*. London.
Commercial Vehicle. *s-m*. New York.
Commonwealth Engineer. *m*. Melbourne.
Compressed Air. *m*. New York.
Concrete-Cement Age. *m*. Chicago.
Cornell Civil Engineer. *m*. Ithaca.

Dept. of Agri. Washington.

Economic Geology. *s-q*. New Haven.
Electrical Engineering. *m*. New York.
Elec. Review and W. Elec'n. *w*. Chicago.
Electrical Review. *w*. London.
Electrical World. *w*. New York.
Electric Journal. *m*. Pittsburgh, Pa.
Electric Railway Journal. *w*. New York.
Electric Traction. *m*. Chicago.
Electrician. *w*. London.
Elektrische Kraftbetriebe u Bahnen. *w*. Munich.
Elektrochemische Zeitschrift. *m*. Berlin.
Elektrotechnik u Maschinenbau. *w*. Vienna.
Elektrotechnische Rundschau. *w*. Potsdam.
Engineer. *w*. London.
Engineering. *w*. London.
Engineering and Contracting. *w*. Chicago.
Engineering Contractor. *m*. New York.
Engineering Magazine. *m*. New York and London
Engineering and Mining Journal. *w*. New York.
Engineering News. *w*. New York.
Engineering Record. *w*. New York.
Eng. Soc. of Western Penn. *m*. Pittsburgh.

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Feuerungstechnik. *s-m.* Leipzig.
Foundry. *m.* Cleveland, Ohio.

Gas Age, *b-m.* New York.
General Electric Review. *m.* Schenectady.
Génie Civil. *w.* Paris.
Geological Survey. Washington.
Giesserei-Zeitung, *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Glückauf. w. Essen, Germany.

Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.

Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Turin.
Industria. *w.* Milan.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trade Review. *w.* London.
Iron Trade Review. *w.* Cleveland, Ohio.

Jour. of Accountancy. *m.* New York.
Jour. Am. Brass Founders' Assn. Buffalo.
Jour. Am. Soc. Heat. & Vent. Engrs. *qr.* N. Y.
Jour. Am. Soc. Mech. Engrs. *m.* New York.
Jour. Am. Soc. of Naval Engrs. *qr.* Washington.
Jour. Asso. Eng. Societies. *m.* St. Louis.
Jour. Boston Soc. of Civil Engrs. *m.* Boston
Jour. Cham. Mines, W. Austral. *m.* Kalgoorlie.
Jour. Cleveland Engineering Society. *b-m.* Cleveland.
Jour. Engng. Soc. of Penna. *m.* Harrisburg.
Journal of Geology. *s-q.* Chicago.
Journal Franklin Institute. *m.* Philadelphia.
Journal N. E. Water Works Assn. *qr.* Boston.
Journal of the Society of Arts. *w.* London.
Jour. of U. S. Artillery. *b-m.* Fortress Monroe.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Jour. Western Soc. of Engineers. *b-m.* Chicago.
Jour. of Worcester Poly Inst. Worcester, Mass.

La Nature. *w.* Paris.

Machinery. *m.* New York.
Madison Engineer. *m.* Madison.
Manufacturers' Record. *w.* Baltimore.
Marine Engr. and Naval Archt. *m.* London.
Marine Review. *m.* Cleveland, Ohio.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *b-m.* New York.
Mining and Engineering World. *w.* Chicago.
Mining and Scientific Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* London.
Monitore Tecnico. *t-m.* Milan.
Montanistische Rundschau. *w.* Vienna.
Motorwagen. *t-m.* Berlin.
Municipal Engineering. *m.* Indianapolis.
Municipal Journal. *w.* New York.

National Engineer. *m.* Chicago.
National Founders Association. *m.* Chicago.
Natl. Mach. Tool Bldrs. Assn. Worcester.
Nature. *w.* London.

Power. *w.* New York.
Practical Engineer. *s-m.* Chicago.
Practical Engineer. *w.* London.
Pro. Am. Inst. Electrical Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Water Works Assn. *yr.* Baltimore.
Pro. Brooklyn Engineers' Club. *yr.* New York.
Pro. Central Railway Club. *b-w.* Philadelphia.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. West. Pennsylvania. *m.* Pittsburgh.
Pro. Inst. of Civil Engineers. London.
Pro. Inst. of Electrical Engineers. London.
Pro. Inst. of Mechanical Engineers. London.
Pro. Inst. of Mining & Metallurgy. *m.* London.
Pro. Lake Superior Min. Inst. Ishpeming.
Pro. New York Railway Club. *m.* New York.
Pro. Railway Club of Pittsburgh. *m.* Pittsburgh.
Pro. St. Louis Railway Club. *m.* St. Louis.
Pro. U. S. Naval Inst. *qr.* Annapolis.
Pro. Western Railway Club. *m.* Chicago.

Quarry. *m.* London.
Queensland Government Mining Jour. *m.* Brisbane.

Railway Age Gazette. *w.* New York.
Railway Age Gazette (Mech. Ed.). *m.* New York.
Railway and Locomotive Engng. *m.* New York.
Railway Engr. *m.* London.
Railway Engng. & Maintenance of Way. *m.* New York.
Railway Gazette. *w.* London.
Railway Master Mechanic. *m.* New York.
Railway Review. *w.* Chicago.
Revista Marittima. *m.* Rome.
Rev. d'Electrochimie et d'Electrométall. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Générale des Chemins de Fer. *m.* Paris.
Revue Générale des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.

Safety Engng. *m.* New York.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *qr.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific American Supplement. *w.* New York.
Shipbuilder. *m.* Newcastle-on-Tyne.
Sibley Journal of Mech. Engng. *m.* Ithaca.
Signal Engineer. *m.* Chicago.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken.
Surveyor. *w.* London.

Telephone Engineer. *m.* Chicago.
Telephony. *w.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Soc. Nav. Arch'ts & Mar. Engrs., N. Y.
Trans. Illuminating Engng. Soc. New York.
Trans. Inst. Civil Engrs. of Ireland. Dublin.
Trans. Inst. of Engrs. & Ship. in Scotland. Glasgow.
Trans. Inst. Min. Engrs. *m.* London.
Travelers Standard. *m.* Hartford.

Werkzeugmaschine. *b-m.* Berlin.
Western Engineering. *m.* San Francisco.

Zeitschr. f. d. gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Ver. deutscher Ing. *w.* Berlin.

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THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. L FEBRUARY, 1916 No. 5

THE IMPERATIVE NEED FOR SHIPS OWNED BY AMERICANS

By Hon. William C. Redfield

United States Secretary of Commerce

Just before the Christmas holidays, Hon. Wm. C. Redfield came home from Washington for a visit with his neighbors in Brooklyn, New York, and before the Civic Club of that city he delivered an address on "The American Merchant Marine," which is so pregnant with facts and convincing logic that it deserves a permanent place in the current literature of that now vital problem.

Probably no man in American public life to-day has had so wide an experience with both the domestic and world-wide development of our manufacturing industries, particularly in the past generation, during which, in the prophetic words of the late President McKinley, "Our capacity to produce has developed so enormously and our products have so multiplied, that the problem of more markets requires our urgent and immediate attention."

In addition to having been a life-long and successful manufacturer, the foreign development of Mr. Redfield's business interests carried him to every part of the globe, Oriental as well as Occidental. This gave him a deep insight into industrial and commercial conditions in every large market of the world, and thus he speaks with the authority of an experienced manufacturer and a trained specialist in the development of our foreign trade.—THE EDITORS.

MAY I take as texts these words from the *Journal of Commerce* of May 6th last: "About 1,000 bales of standard drills were sold for shipment to India last week and more could be sold if satisfactory shipping arrangements could be made," and also this extract from the monthly statement of the National City Bank, New York, for May: "The lumber industry would be very much helped by the British demand, if ships were available. Mills in Maine, the Southern States, and the Pacific Northwest are being hampered by this situation." Against these let me offset these words from the *Economist*, London, of November 13:

"In future the Government may requisition for the carriage of grain and other merchandise any ship registered in the United Kingdom, and after December 1st no British ship of over 500 tons may carry cargo from one foreign port to another without first obtaining a license from a Committee in London. All British shipping is liable to be requisitioned for commercial purposes; all trade in British bottoms between foreign ports is to be under direct Government control.

"These are revolutionary measures, which

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nothing but urgent necessity could justify and the full effects of which it is impossible to foretell."

The major facts of to-day respecting the shipping situation are unique. They present a spectacle in which one great fact, that would in ordinary times be controlling, is offset by another fact of equal weight, the whole forming a collection of extremes new to our knowledge.

Our merchant marine was never as large as to-day. The increase in it was never as large as in the last fiscal year. It is growing to-day faster than it ever grew before. We never needed ships as badly as we need them now. We never were more dependent upon foreign ships than we are now. Never did this dependence rest on a more shaky foundation. Never had we so much of a marine. Never did we suffer so much from lack of one. Never did we add to it so fast. Never was our helplessness to add to it sufficiently more marked.

A shipment of flour to Egypt is stopped at the dock because others need the ships that had contracted to carry it, and our shipper is helpless because of the war clause in his contract. When in normal dependence upon a contract another shipper forwards goods to your port for foreign transit, the vessel that was to take them is commandeered by its government, and our shipper protests in vain. In Brooklyn a large shipment is refused transit because the shipper has not signed a certain agreement having nothing to do with the goods which are refused. Even a shipment from New York to Manila (between two ports of the United States, it will be noted), is refused transportation unless the shipper will sign an agreement as to the nationality of the consignee.

You will observe that it is not a question of rates, or even in all cases of vessels, but rather that since we must depend on ships of alien ownership to carry our goods, it is clear that when the interest or the duty of those alien owners requires them to put their own necessities first, we helplessly stand aside. Just so far as these things go we are not an independent people. We do our trade by the consent of others when it pleases them to have us do it, as it pleases them to have us do it, and to the extent that it pleases them to have us do it, and under rules which they lay down. That is the condition in which we now stand. Until we shall get enough American ships we must accede to the necessities which may and now do impel alien owners of vessels to action hurtful to us.

In our export trade are two great divisions—the temporary and the permanent. It is our interest to promote the latter. It is to some extent the interest of our customers to promote the former. The farmer, the merchant, the mechanic, the miner are alike interested to have American commerce flow freely to all parts of the world where it wills to go, under control of those in sympathy with it and whose duty it is to promote it. We have been a department store without a delivery system, depending on our rivals for the use of their wagons. Now there are fewer wagons than there were and our need for delivery is greater than it was. Our rivals, indeed, want us to use so many of their wagons as will take to them the goods they need. They do not care to have us use other of their wagons because they need them themselves in their business, and their business just at present is not our business and is more important to them than our business is. So we are out of it in large part till we get wagons of our own. So much briefly for the need.

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Our facilities are strained to meet it. On July 1st last we were building 76 steel merchant vessels in our shipyards. Between July 1st and December 1st 126 had been ordered, making 202 in all, of a total of 761,511 gross tons. The construction of American merchant vessels now in progress or under contract is not only greater in tonnage than at any former time in the history of the United States, but this new tonnage is more efficient than the merchant ships constructed at any previous time in our history. Indeed there is competent authority for saying that the American freight steamer by reason of her design and equipment is a more efficient tool for transportation than her foreign competitor.

Despite the great past and present increase in our ocean shipping, we are yet sadly handicapped in our foreign trade, and much as we are doing we are still unable to seize to the full the opportunity at present offered us. Every craft that can by courtesy be called a ship is in service. The familiar coasting schooner is in the Mediterranean coal trade, and if there were more of them they could be so employed. The English merchant marine has either lost or is using for war purposes one-quarter its full strength, perhaps more. In a degree, the same is true of the other belligerent powers, and, of course, certain fleets are absent from the seas.

We have made some use and are making better use all the time of our opportunities during the war, and should Great Britain or Germany require their ships for their own restored trade when the war ends, we shall need American ships to do the larger business we are finding with neutral countries, unless we are content again to lie down and do this business as of old at the will of others and for such a time and in such a way as they wish us to do it. I take it, however, that the United States has gotten a larger vision than it had two years ago, and that by the extension of banks and other mechanisms of trade, it is reaching out more than it ever did into the greater world. I think this process will not be denied and can not be stopped and that we shall insist upon doing it where we please and as we please and for our own benefit though with due regard to the rights of others, and this means that we shall think it necessary to do it in ships which, if there were difficulty anywhere, will be concerned to do things our way.

I have not touched yet upon another serious factor in this matter. Great Britain is using something like 3,000 ships as attendants upon her great war fleet. These are of many kinds but they are all merchant vessels, yet without them the war fleet would be helpless. When we sent one fleet of battleships around the world some years ago, we had to hire foreign vessels to keep them in coal and supplies. We do not make the navy to keep it in ports, but we have not the means, to be candid, to keep it long at sea. It would require about 900 ships of all kinds from the merchant service to keep it well supplied at sea, and we have not those ships. We have about 500 and that is not enough, and so our navy would have to leave its job and come home to get coal and supplies at the time when it was most needed at sea. That is, it would do this unless we get more ships. We need 400 more at least, and we ought to have them as soon as possible, and there ought to be no doubt about it. Observe that if we took all the vessels estimated to be available for this purpose, we should still be short 400.

We need, then, ships not alone for

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the present emergency, much as they are needed there, but for the maintenance of our commercial independence on the sea and for the support of our navy should it be required for our defense. How shall we get them? It is not a job to be delayed, for time is of its very essence, yet every private yard is full for about two years to come. They may be, I trust they will be, extended or multiplied, but it will be necessary to have some assurance of business sufficient to warrant the investment in so doing. We have a few government vessels capable of carrying coal or cargoes, which we cannot use for lack of lawful authority, else they might be doing useful work today for private commerce and, in some measure perhaps, tend to hold down the rates exacted of our citizens elsewhere.

I have not spoken of freight charges because we know that much of what is said concerning them will not bear analysis. In our export trade the buyer pays the freight, and it only affects the American seller by adding to the expense of the transaction, and, hence, to his difficulty in making his sale. The actual money paid for outward freight, however, is not paid by us, but is paid by the foreign buyer to the foreign ship owners. So also of other charges on the outward shipment. The bulk of freight we pay to foreign owners, though considerable, is not in its aggregate serious as compared with the total of our commerce or with the necessity that that commerce shall be conducted by friendly hands and under our own control. It is a fact, however, that bears heavily upon us that ocean charges are now from six to ten times what they were before the war.

Apart from the private yards, there are government plants capable of shipbuilding in various navy yards, most of which can build something if properly equipped, but also most of which now build nothing. I should like to see such yards equipped for building merchant ships under the supervision of naval constructors to see that they are substantially constructed for use as possible naval auxiliaries in time of need, but to be used by private concerns as part of our merchant marine in time of peace. Personally, I should be glad to see this whole matter of the merchant marine put in the hands of a shipping board, a majority of whom should be from civil life, who would have no other business or function than to watch over and promote the merchant marine of our country. I should give them broad supervisory powers. They should be empowered to construct in private or public ship yards vessels for the merchant marine, or to purchase them and to charter, lease, or sell them to individuals, firms, or corporations, desiring to use them in the foreign trade of the United States or between its ports and those of our insular possessions. This would be the principle of public ownership with private operation, so exemplified in the New York subways. I should not stop at this, however, but would give the shipping board power to organize a corporation or corporations and to subscribe, on behalf of the United States, to part or all of their stock, as the judgment of the board might after discussion think best; and in the open, in order that the inability of private capital might in such cases as should prove necessary be supplemented by the power of the Government. There are cases where American commerce as a whole may need communications which private capital can not, and under its necessary conditions ought not, to supply, but which the interests of all may for a time at least require

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that it be done at the expense of all. Under these conditions the shipping board should have power to act for the general good and also power to sell the stock which it owned, whether as a minority or a majority holder in the corporation. The board should be empowered to provide for ships under the American flag the privilege of shipping for specific sailing, and where need existed, after public discussion, it should have the power to grant preferential rates in American ships. It should have as its supreme duty the continuous promotion and upbuilding of our merchant marine, taking into strict account also its availability as an auxiliary in time of war and having due provision made for that in the act creating it.

The one greatest element of value in the plant which I suggest as my personal view would be the creation of the board with the duty to hear and with power to act. It must so hear and act in the open, and that which is openly done must be guided and controlled by the public opinion which is the master of us all. Such a board, so active and so guided and in the presence of a Congress which reflects public opinion, need not be feared. Should it go astray, it must do so in the sight of all men and in the presence of a power which can correct it. The law which gave it birth might at any time terminate its life. There is precedent for both. Law gave birth to the United States banks. Law permitted the taking by the government of stock in those banks.

We need not be concerned about any talk of socialism. It is absurd to say that New York has gone over to socialism because it owns its own docks and its water works, or operates its own ferries or asphalt plants. The United States has not gone over to socialism because it is building a railway in Alaska or operates another in the Far West, or runs the Panama Railroad Company and the steamship line connected with it. There has been no terror impending over our heads because the Government has long owned and run some of the steamers to the Isthmus, and has chartered and operated others. Surely the people of the United States are not afraid of a word. Need one fear to say that socialism, or any other ism or cult, may contain one element of truth, and need we be afraid to use a truth because it is a portion of some creed or faith which we may not as a whole accept?

One thing ought to be clear to us all, that whereas the nation was blind to the need of its own shipping, now it sees. I confess to some impatience with hard-frozen opinions that will yield nothing unless the marine problem is worked out in just their own personal way. There is no great measure which has benefited and blessed our country that has not before its birth been proclaimed as a bringer of evil. In very recent times the Federal Reserve Act, on which we all now gladly depend and which we recognize as an anchor and safeguard, was condemned publicly by men whose profession and experience was such as would cause them to be esteemed sound leaders of opinion. May we not lay aside something of pride of opinion and get together on this subject, trusting that common sense discussion and the future will alter and amend such things as are unwisely done in the respects in which they need correction, but remembering that the nation requires its ships on every sea to be its messengers in peace and its supporters in the storms of war.

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INDUSTRIAL LESSONS FROM THE GERMAN WAR MACHINE

By C. E. Knoeppel

I. THE GERMAN MILITARY ACCOMPLISHMENT

Several years ago we presented in these pages an admirable series of essays on Business Administration, by Edw. D. Jones. Some of those essays took for their theme the study of the military leaders of the world and the lessons in business administration to be learned from them. Mr. Jones was forced to go back through the ages for his models. Mr. Knoeppel, on the other hand, takes his examples from the current news reports, and the lessons he points out are full of meaning to the observant manager.—THE EDITORS.

WITH England, France, Germany, Japan, Russia, Servia, Bulgaria, Montenegro, Belgium, Austria, Turkey, and Italy engaged in the greatest armed conflict in the world's history; with Greece and Roumania likely to become involved at any time; with the United States, France, England, Germany, and Austria engaged in a war of "diplomatic notes," it seems fitting to pause and devote some attention, not to a discussion of war, but to a study of the lessons this catastrophe can teach us in our efforts to enlarge and maintain "our place in the sun."

What is the one big thing in this war which overshadows everything else? German *EFFICIENCY*. Regardless of whether our sympathies are with the Germans or the Allies; regardless of whether the Germans are right or wrong in this war; and without considering the methods they use to achieve their ends, all must admit that they are showing the rest of the world an *efficiency* both as to organization and methods that is nothing short of marvelous.

At the outset I wish to disarm the natural suspicion of the reader, who might say after looking at the name of the writer, "Oh! he is a German." I might have followed the suggestion of Dr. Melville Dewey, who advised me to spell my name "Nopl" and in this way guard against this possible accusation. I was born in this country, however, as was my father before me. My ancestry is as much French (Requa) as German (Knoeppel), so if racial tendencies account for anything, I should be fighting with myself.

I admire *efficiency*, however, no matter where it is found. The Germans have demonstrated without question a high degree of efficiency in the conduct of this war and as I see in it an opportunity to point out certain lessons of value to American Industry, I feel I will be pardoned for using the Germans as my text. In connection I wish to say that I am not predicting that the Germans will win —it seems, in fact, impossible, considering the odds against them—nor do I want to be considered as even favoring the German cause, for I am trying to be neutral like every real American. I do want to impress upon you, however, that while the German nation and thought may to be one thing, the German method is distinctly another, and it is with this which we, as a people, should be most concerned, not letting our likes or dislikes run away with our judgment.

A true conception of the gigantic proportions of this conflict is in order

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before we can really judge the accomplishments of the Germans. This we can divide into: Relative strength, size, losses, and cost.

As regards relative strengths, the following will prove interesting:

Wealth of Allies	$204,000,000,000
Wealth of Central Powers.	108,000,000,000
Relation 1.9 to 1.	
Population of Allies—Europe..	266,500,000
Population of Central Powers—Europe	122,200,000
Relation 2.1 to 1.	
Population of Allies—Colonies.	472,500,000
Population of Central Powers—Colonies	32,800,000
Relation 14.4 to 1.	
Armed War Strength—Allies..	7,940,000
Armed War Strength—Central Powers	5,260,000
Relation 1.5 to 1.	
Naval Strength in Tons—Allies	4,780,000
Naval Strength in Tons—Central Powers	1,750,000
Relation 2.7 to 1.	

Note: Bulgaria is not included with Central Powers.

From this it can be seen that from the standpoint of wealth and population, and in armies and navies, the Allies have by far the better of it.

As to size, approximately 75 per cent of the population of Europe is at war, or, to put it another way, 50 per cent of the population of the world is engaged in this conflict in one form or another. Practically 15,000,000 men are under arms, with more being recruited and trained. Losses for the first twelve months were approximately 2,000,000 killed or permanently incapacitated; 3,000,000 captured, and 4,000,000 wounded. At no time during the Civil War did the number of men engaged exceed 1,500,000 with Northern losses of 110,000 and Southern losses of 80,000. In 1812, Napoleon invaded Russia with 500,000 men, which was the largest army up to that time. *In other words, as to the number of men involved, this war is ten times as great as our Civil War.*

With reference to losses, the following estimate covering the first year of the war is offered:

Nation	Killed or Permanently Incapacitated	Captured
Germany	420,000	150,000
Austria	350,000	300,000
Turkey	50,000	40,000
Total	820,000	490,000
Russia	1,000,000	2,000,000
France	360,000	275,000
England	80,000	25,000
Italy	40,000	5,000
Servia	40,000	20,000
Belgium	30,000	30,000
Total	1,550,000	2,355,000
Grand Total.	2,370,000	2,845,000

Relation Allies to Central Powers—Killed 1.9 to 1.

Relation Allies to Central Powers—Captured 4.8 to 1.

As to cost, the estimate most used is $50,000,000 for both sides per day, or $18,250,000,000 per year. As the combined wealth of the nations at war is $312,000,000,000, this means that these nations are spending yearly an amount equal to nearly six per cent of their wealth.

After this conception of what this war really is, let us take up the question of accomplishments. After twelve months of the war, David Lloyd George said: "The iron heel of Germany is sunk deeper than ever into French and Belgium soil; Poland is entirely German; Lithuania is rapidly following. Russian fortresses deemed impregnable, are falling like sand castles before the resistless tide of Teutonic invasion."

In a more detailed way, you see Germany taking the initiative on all sides. At the outset she subjugates Belgium and starts a drive toward Paris, then retreats, and taking the defensive, digs herself in, in such a thorough manner that despite the fierce offensive of a few months ago, she is in an almost impregnable position as indicated by the following despatches:

"New York, December 24.—General Joffre spared no pains in vigorously forcing his views on the British cabinet and the general staff. He told them plainly that

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the battle of Loos had had no practical value whatever. In his opinion the results attained were in no way commensurate with the expenditure of life and munitions. According to Joffre the position on the West was a stalemate and hope of any real success was next to impossible. The only hope was to make a great effort by way of the Balkans."

"Brookline, December 6.—Reverend Van Ness interviewed many soldiers in British hospitals, and from them gained an impression that the German position on the Western front is impregnable."

Germany was on the defensive in Russia at the start of the war, then took the offensive, and, in the campaign which followed, captured ten of the most productive Polish provinces and six of the most valuable provinces in European Russia. It will take more power than Russia has shown to dislodge the Germans.

To relieve Turkey and lift the siege of Constantinople, she conquered Servia and opened the road to Turkey, forcing the Allies to abandon for the present the capture of the Gallipoli peninsula, after which she forced the Allies who were sent to assist Servia to retreat to Saloniki and fortify it against a possible and no doubt expected invasion.

If she starts a drive on Egypt or India it will be the same story all over again. The Allies will be forced to change their plans and shift their forces.

She is successful first in getting Turkey to join her, and then in convincing Bulgaria that her interests and those of Germany are identical, in both of which cases she shows a greater ability at diplomacy than the Allies.

In the dispatches of December 16, we read that Marghileman, leader of the Rumanian Conservatives, in an audience with the king suggests that the time is now ripe for Rumania to join the Central Empires and invade Russian Bessarabia. Also that when the name of Venizelos, the Greek ex-premier, was mentioned in the Odean Theatre at Saloniki, the crowd shouted, "Down with the traitor." It would not be surprising to the student of this great war to see Greece or Rumania, or both of them, fighting with Germany before the war is over. At any rate, the entry of Bulgaria and the holding off on the part of Greece and Rumania seems to indicate that these nations have a definite idea as regards who is going to win.

It is nothing but a gigantic chess game, with Germany making the strongest and most vigorous plays, for behind it all you find the German direction, the German organization, the German planning, and the German resources. Surely the study is worth while and rivals a tale from the Arabian Nights.

Take the question of officers, for example. With an uncanny foresight and a skill almost devilish, the Germans have trained sharpshooters to pick off English officers, and the individual initiative and courage of these officers simply made it all the more easy for the Germans. On the other hand, you find German officers transforming the weak Turk into a fighting man and making the fierce fighting Bulgarian all the better through German direction.

Look at the general conduct of the war for a moment. In the French, Russian, and especially the British cabinets, there has been conflict, criticism, abuse, and repeated changes. Von Moltke is still Chief of Staff at Berlin, and Von Falkenhayn, Chief of Staff in the field. Sixteen months after the start of the war the Allied Powers sent representatives to the first General War Council held in Paris for the purpose of bringing about closer co-operation among the Powers in military operations.

You see Joffre going to London and forcing Britain to change her plans,

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as indicated by the following dispatch:

"New York, December 24.—Oppositions to these views were exceedingly strong at first, but Joffre battered down all obstacles and ultimately was allowed a free hand. Consequently, the British troops on the way from Gallipoli were diverted to Saloniki where they are now being landed."

You see the British starting the Dardanelles campaign and finally, concluding that it would be sheer madness to make further attempts to pierce the Turkish positions, withdrawing three-quarters of their troops and transferring them to Servia and France. The Allies, it will be remembered, go to the relief of stricken Servia, but arrive when it is too late, due to the swiftness of the German and Bulgarian advance, and are forced to retreat to Saloniki, destroying their own property as they retire.

Take generalship for another example. Is there one Allied general who compares in accomplishment with Von Hindenburg, or Von Mackensen, or Von Kluck? It is, of course, true that Grand Duke Nicholas, in his retreats in Russia, and General Joffre, in holding the Germans in France, are entitled to great praise for their strategy, but the real strength from the standpoint of rapid advance, vigorous action, and smashing tactics is certainly with the German generals.

What Germany has really accomplished can be best appreciated by showing, not the amount of territory captured, but the resources in this territory, as follows:

Belgium:—practically all resources.

Servia:—same as Belgium.

France:—coal, 69 per cent; iron ore, 90 per cent; pig iron, 86 per cent; textiles, 69 per cent; or 43 per cent of the total resources.

Russia:—one-fourth coal output; one-fifth of the weaving mills; one-tenth of the flax industry; one-sixteenth of the hemp industry; one-tenth of the iron and steel industry; one-third of the potato acreage; one-seventh of the live stock; one-sixth of the railways; nearly all of the zinc and copper; and a large extent of the oil fields in Galicia.

Let us look at the Balkans for a moment. In every sense of the word, this drive was a master stroke, for it accomplished five things. It relieved Turkey; forced the abandonment of the Dardanelles campaign; eliminated Servia; blocked any possible offensive through the Balkans; and exerted a powerful influence on Greece, Rumania, and the Far East.

England fully realizes the seriousness of the Balkan struggle. The London *Morning Post*, giving the views of Seton Watson, the well-known authority on the Balkans, quotes as follows:

"If Servia went under it would mean that the route would be open to Germany to supply men and munitions to Constantinople to arm against us the 500,000 or 700,000 Turks who still could not be armed at home. Turkey would be saved. The Dardanelles would go. The position would be untenable unless Servia, and we with her, hold the breach. The news would run like an electric flash through the entire East, our prestige in Egypt would be gone. Our position in Mesopotamia would be threatened. Every bazaar in India would ring with the news and Persia would be in arms.

"If Servia went under, Germany would get all the cotton of Asia Minor, all the oil of Persia, all the copper of Servia and also corn. To talk of a war of attrition after that is an absurdity. It would also deprive us of the real field of a promising offensive through the Balkans and Austria Hungary."

It may be interesting in connection to know how Germany saved her merchant fleet just before the war. Germany's chain of wireless stations in all of her colonies cost her $10,000,000. Godfrey Isaacs, Managing

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Director of the Marconi Wireless Telegraph Company, Ltd., at its annual meeting in London said:

"In the light of what subsequently happened, you will probably say that it was a very bad investment; but you would be mistaken. You will remember that this country declared war on Germany at midnight of August 4 last. At five o'clock in the afternoon of August 4, Germany sent out a message to all its wireless stations, which passed that message on from one to another, and sent it out to sea, covering a radius of something like 2,000 miles or more—a message to this effect: 'War declared upon England. Make as quickly as you can for a neutral port.' By that message, which occupied but a few minutes, Germany contrived to save the greater part of its merchant mercantile marine. If it had but saved one of its big ships—the Vaterland or any one of that class—it would have paid for the whole cost of these wireless stations. We all know that it was a great deal more than that, and that it did a great deal more than send this message to its mercantile marine."

The German method of laying railroads is another example, as will be seen from the following dispatch:

"Paris, November 30.—The remarkably effective system of railways and telegraphs which the Germans have constructed to connect with Field Marshal von Hindenburg's forces along the Riga-Dvinsk front, is described by Charles Rivet in a dispatch to the *Temps* from Petrograd. He says that the Germans have given full scope here to their genius for organization and that their railways have excited the admiration of all who have seen them.

"These lines are brought from the rear to the front in pieces, like children's toys, and are immediately linked together. Thus a network of rails extends behind the entire front. At the same time they have constructed three main lines from East Prussia to the Riga-Dvinsk sector. These lines have regular schedules and are open to the public. There also are electric tramways connecting the small villages, notably around Poniewesch.

"Similar efficiency has been shown in construction telegraph lines in all directions."

The establishment of train service from Lille to Warsaw is still another example of accomplishment, as the following message cabled by the staff correspondent of the New York *Times* from Berlin on August 17, 1915, will show:

"Lille-Warsaw express. These words record another German mechanical and technical triumph.

"Eleven days after the capture of Warsaw, the military railroad officials have inaugurated a through train service, connecting the extremes of occupied enemy territory, leaving Lille at 6.40 o'clock in the morning, Brussels at 8.30, and Berlin at midnight, and arriving at Warsaw in time for luncheon the next afternoon.

"The first trip of the new train eastward from Berlin carries a party of seven American war correspondents, including the *Times* representative, who are going to witness the bombardment of Fort Novo Georgievsk."

The following extracts from a long article in the great Russian liberal paper, *Russkae Slovo*, on "German Methods of Modern War," is a most eloquent testimonial to the remarkable *efficiency* of the Germans:

"According to their custom, the Germans rush precipitately forward, and hardly have they occupied a new position when they fortify it in such a fashion that the forces necessary for the defense of what they have won can be reduced to the minimum. The trenches of the Germans are kept in remarkably good order and relatively almost empty; every thirty or forty yards you find a machine gun. But behind the trenches circulate the movable stores of ammunition, so that ammunition may be dealt out quickly where it is needed. This is always quickly at hand, and stored up, with all attendant confusion avoided. Never any superfluous thing in the trench, but rather space, light, air, cleanliness.

"At Libau, the Germans used gigantic automobile trucks in which liquid cement was brought up with which the trenches were strengthened and made proof against shells. These power trucks too had another use. They were equipped with great watertight containers which enabled the German soldier to have his weekly, or even daily bath.

"These Germans keep their trenches as clean as they do their bodies. And then, too, we find in every German trench a broad board, which serves as a table. With us nobody ever had the idea. Our soldiers eat their food on their knees, throw breadcrumbs and bones on the ground, and even the remnants of their food. Thus our trenches are rapidly converted into great refuse pits. With the Germans it is quite different.

"Again, they strive to have as few soldiers as possible in a trench; they don't want their soldiers to be exposed to fire needlessly. But they have telephone stands everywhere. At the slightest alarm the

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telephone goes into action, the Greman trenches being simply covered with a network of telephone wires. All commands are transferred by telephone, which means a great saving in officers as none are required for the transmission of orders.

"So as not to lose any cannon, these Germans, again, make use of powerful motor trucks. Our officers were at first astonished; they would capture a German trench or German position, and would find there only a few German soldiers and no cannon, no machine guns, and no ammunition at all. What had become of it? It was only later that we learned that the Germans have heavily armored motor cars, which during the battle are stuffed full of ammunition; but at the slightest danger for the cannon—especially the heavy ones—these are hitched with chains to the automobiles and drawn away, so that we are left to look on.

"In short, with these Germans everything is provided for and everything foreseen, from the bread crust which must not be thrown away to the sheet of letter paper which is handed out only at the right time. In fact, this is a war which the German has entered with all his soul, and at the same time with all his brains."

It is said that almost every copper kettle is in the hands of the German Empire. Even fruit seeds have been systematically collected and yield from 15 to 30 per cent in oil when pressed. The claim has been made that the gas bomb is equivalent to ten thousand shrapnel shells. In the drive from Galicia, it is said that the Germans put three shifts of men at work in the mines and oil fields. They are extracting nitrogen from the air. A recent dispatch informs us that they have found a way to manufacture synthetic rubber. Wood pulp and other fibres have been substituted for cotton in explosives. They use benzol produced from coal for internal combustion engines. To feed their cattle they found a way of extracting fodder from straw. They inventoried everything eatable in the Empire, studied the demand, then matched the two. They supervised the production of food and superintended the manufacture of munitions. You know of the German development of the sea-going submarine; the bringing out of the invisible gray uniform; the surprise caused by the use of the 42-centimeter guns.

For a few moments let us transfer our attentions from *efficiency in accomplishment*, to *strength in resources*. In his book, "Through Terror to Triumph," a year after the war started, David Lloyd George said:

"What is the actual position? It is thoroughly well known to the Germans, and anyone in any land, belligerent or neutral, who reads intelligently the military news must by now have a comprehension of it. With the resources of Great Britain, France, Russia—yea, of the whole industrial world—at the disposal of the Allies, it is obvious that the Central Powers have still an overwhelming superiority in all the material and equipment of war."

The nation behind the war is worthy a few words. Let the Hollander, who in the *Nieuwe Courant*, of Amsterdam, gave his impressions of his trip through Italy and Germany, tell what he observed:

"I discovered neither famine nor lack of work; no people depressed and eager for peace. Although the newspapers of the Quadruple Entente had prepared me to find a shortage of soldiers, I could not see it. Germany continued to live its normal life. People bought goods, they kept on traveling, money appeared to be plentiful. There was plenty of luxury in evidence. Where the money came from, I am unable to say. To all appearances the war was bringing good business. The entire land seemed to me like a garrison. Everywhere I saw new, trained, soldiers. Not children, nor old men, but soldiers flushed with health and young manhood; men in their best years.

"In spite of the tremendous efforts in the east, notwithstanding the numerous strength on the western front, there seemed to be not the slightest diminution in human material. The great result of the campaign in the east brought along a renewed national consciousness. No one could be found who did not believe absolutely that final victory would fall to Germany. To be sure, many mourned the great losses sustained, but not a soul desired on that account to give up until fully victorious. The nation is even now preparing for another winter campaign. All submit to the inevitable, while resting complete confidence in the Government and the army leaders.

"We may quarrel, if we will, over the question whether Germany had this war

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long in preparation, whether it wanted the war, or began it. But an organiation that can display such national energy as Germany has done deserves notice. The individual, the masses, the whole nation have but one aim—victory. It is in the air; it vibrates throughout the atmosphere like the electrically-charged room affects the motors and the machines. The individual has nothing to say. Individualism is submerged. There is unity in thought, in feeling, in action. Here lies Germany's strength. Not in its howitzers, not in its submarines, not in new chemical discoveries, nor in the organization of production and distribution. All these are but manifestations; only instruments of use because of that tremendous force back of them—the marvelous energetic power of the soul of the German people.

"We can admire this gigantic influence and power; hate it, or despise it, as we will. It cannot change the fact. This is what the Allies must attack and tear asunder. The question is whether they possess the necessary means to accomplish this task."

Recuperative power of the nations at war is worth considering in connection, as it enters into any discussion of resources. Let us compare the annual contingent of men arriving at military age with military training with the killed, permanently incapacitated, and the captured; the the wounded that can again join the colors not being considered. The figures for the first twelve months are:

Nation	Men Lost	Annual Contingent
Germany	570,000	600,000
Austria	650,000	530,000
Turkey	90,000	200,000
Total	1,310,000	1,330,000
Ratio contingent to losses, 1 to 1.		
Russia	3,000,000	1,735,000
France	635,000	250,000
England	105,000	.....
Italy	45,000	374,000
Servia	60,000	35,000
Belgium	60,000	.....
Total	3,905,000	2,394,000
Ratio contingent to losses, 0.61 to 1.		

The debts of the nations at war will also be interesting in connection, as they will give some idea as to the real strength from the standpoint of credit and borrowing ability. The per capita debt previous to the war was as follows:

Germany	$17.81
Russia	27.02
Great Britain	76.35
France	160.24

The United States debt is $10.70 per capita.

You see the Allies borrowing money from the United States as well as raising all they possibly can in their own countries. You see England loaning to those fighting with her, while Germany does her financing at home, the money going from one hand to the other and back again, so to speak. You see the Allies spending their money like water for supplies and munitions, and, controlling the seas as they do, have the whole world to call upon for all they can pay for; while Germany, being blockaded by the Allied fleets, can get in but little from the outside. Will there be a pinch in Germany? The factors are:

Food,
Munitions,
Men.

We have seen from figures and statements that the shortage, if any, will not be in men. Lloyd George told us of the superior advantage of the Central Powers in munitions. As to food, Austria Hungary was practically self-supporting before the war, while Germany produced up to 80 per cent of her needs. In iron and coal Germany was better off than her opponents. Add to all this the resources of the captured territories of Belgium, part of France, part of Russia and Servia; with markets of Bulgaria, Turkey, and the Orient now open to her, and the optimist will have a hard time figuring out how the Central Powers are going to fail to get their minerals and supplies with which to make munitions and carry on the war. Between the oil fields of Galicia, the cotton-growing possibilities of Asia Minor, and the minerals of the Balkans, the Central

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Powers seem well fortified against a shortage in materials.

Look at it from another angle. With Germany, Austria Hungary, the Balkans, Poland, and Turkey one vast economic empire dominated by German *efficiency* and German *kultur* (already 14 German professors are to be assigned to the Turkish University of Stamboul to teach the Turks the culture of Germany) Germany will control Asia Minor and, with proper management and the wonderful railroads Germany can give, will be able to supply the whole of Europe with its needs. Improbable perhaps, but certainly not impossible if Germany wins, and nothing has transpired so far to indicate that she can be decisively defeated.

This is a war of munitions more than it is one of men or money. The field of chemistry and mechanics has been drawn upon as never before; and in science, applied chemistry, and industrial efficiency, Germany leads the world. *What is behind it all?* Here is a group of nations outnumbered, outresourced, cut off from the outside world, accomplishing things which challenge admiration. The Germans, according to all logical reasoning, should be down and out completely—exhausted financially, agriculturally, and industrially, in minerals and in men. All who have followed the war to date know that all logical reasoning has been upset. If the war should end today, Berlin would dictate the terms of peace.

Why this success? The German strategy has been excellent, but so has that of Russia, and France; especially that of Russia in her recent retreats. The German is a good fighter, but the English, French, and Russian soldier is just as good a soldier. The tactics of one are just as good as the other. In other words, as regards fighting, you can take your choice. There is something deeper behind it all than mere fighting ability.

Surely, considering everything, Germany is performing the seemingly impossible, and warrants the *Kölnische Zeitung* in saying:

> "With amazement will the neutrals observe once more the calm strength and organization of Germany, which on one front is sustaining without swerve a gigantic offensive and conducts on another front an offensive of the largest scale, keeps in hand and administers in a model manner territories as large as some of the European states in the East, and in the West, protects its commerce and furthers new enterprises of the greatest importance, delivers successful blows at sea and from the air, and succeeds at the same time in bringing about, out of her own accumulated strength, the greatest domestic loan in the history of finance."

The answer is *efficiency*. This war is the greatest example of *efficiency* on the one hand and of the lack of it on the other of this or any other time. Condemn the German all you please, but if you consider what he has accomplished you will be forced to praise his *efficiency*, for if this war does nothing else but give the world a true conception of the theory and practice of *efficiency*, it will have served a real purpose and will in a measure compensate for the enormous losses.

To this country this war can teach a great many lessons, as it is teaching them to England, France, and Russia at the present time.

Back of the German military efficiency is the German industrial efficiency, a fact that all who are advocating "preparedness" in this country should not ignore. Our first striving should, therefore, be for *industrial efficiency*, and the purpose of the next paper will be to point out the industrial lessons which the German war machine can teach American manufacturers.

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AMERICAN ENGINEERS ENTER THE FOREIGN FIELD

The largest and most influential manufacturing, railroad, mining, and engineering corporations of the country have combined with the big banking institutions for the purpose of promoting, enlarging and creating foreign trade for American products. Believing that our readers would be interested in learning about the plans of the organization, we saw some of the officials of the new American International Corporation and obtained the following authoritative outline of its field of activities.—THE EDITORS.

THE opportunity long searched for by the engineering industries of the United States to extend their enterprises into foreign countries and to build up abroad steady markets for their products under conditions of trade reasonably free from annoyances and uncertainties is at hand. Through the organization last November of the American International Corporation, there has been brought about an instrumentality of commerce which is scientifically designed and financially equipped not only to stimulate engineering enterprises in foreign lands but to create through them a steady and easy-flowing market for American engineering products.

In magnitude and carefulness of design the new corporation exceeds any other organized effort in commercial history to coordinate the forces of foreign demand and domestic supply. What the East India Company was to the development of Great Britain's Asiatic commerce and what the Hudson Bay Company was to the development of Canada conveys only a partial idea of what the American International Corporation is purposed to be to the industrial and commercial development of this country.

Both in scope of organization and in the support it commands from the leading financial and industrial interests of the country the new corporation stands unique. It is essentially a co-operative enterprise; for it enters upon its world-wide work not as a grasping competitor but as a benevolent helper of commerce and industry, inviting the co-operation and support of business men throughout the world. It is organized under the laws of New York State with a capital of $50,000,000, and with a charter that is so broad as to enable it, if need arises, to carry on almost any kind of business enterprise and to acquire almost any kind of property.

The chairman of its board of directors is Mr. Frank A. Vanderlip, president of the National City Bank of New York City, with which the new corporation is closely affiliated. Its president is Mr. Charles A. Stone, head of the firm of Stone & Webster of Boston, well know as engineers and managers of public utilities. Mr. Stone himself is one of the foremost business men of this country and has won the reputation of being a "vitalizer" of business, more than fifty public service corporations having been organized under his firm's direction. Mr. Willard D. Straight, formerly an official representative of the United States Government in China and recently connected with J. P. Morgan

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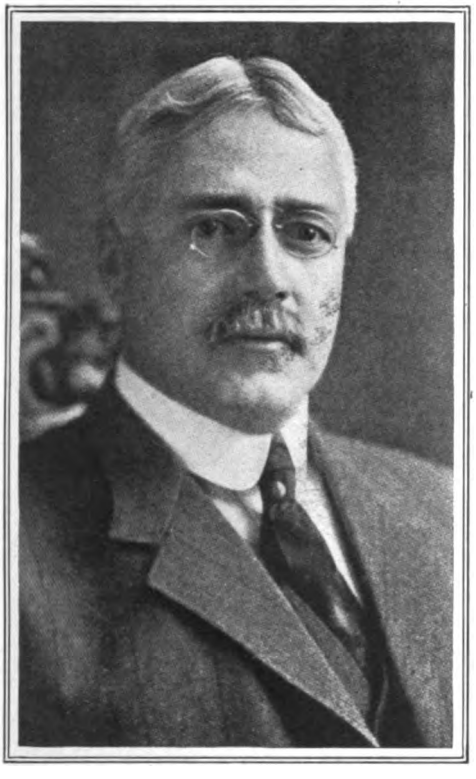

FRANK A. VANDERLIP, CHAIRMAN
President, the National City Bank

CHARLES A. STONE, PRESIDENT
Stone & Webster Engineering Corporation

& Company, is vice-president of the new organization. Mr. R. P. Tinsley, formerly treasurer of the Standard Oil Company and intimately connected with its foreign trade for many years, is the secretary and treasurer. Its board of directors includes the following: J. Ogden Armour, of Armour & Company; Charles A. Coffin, of the General Electric Company; William E. Corey, Midvale Steel & Ordnance Company; Joseph P. Grace, W. R. Grace & Company; James J. Hill, the Great Northern Railway Company; Otto H. Kahn, Kuhn, Loeb & Company; Robert S. Lovett, the Union Pacific Railroad Company; Ambrose Monell, the International Nickel Company; Henry S. Pritchett, director of the Carnegie Foundation; Percy A. Rockefeller, the Standard Oil Company; John D. Ryan, the Anaconda Copper Company; Charles H. Sabin, the Guaranty Trust Company; William L. Saunders, the Ingersoll-Rand Company; James A. Stillman, the National City Bank; Theodore N. Vail, president of the American Telegraph & Telephone Company; Edwin S. Webster, of Stone & Webster; Albert H. Wiggin, the Chase National Bank; Beekman Winthrop, Robert Winthrop & Company.

The engineering interests of this country cannot fail to recognize the vital significance which this new organization holds to them. Naturally the question must arise, what will be the relationship between the two?

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From Paul Thompson, New York.

WILLARD D. STRAIGHT, VICE PRESIDENT
Formerly with J. P. Morgan & Company

R. P. TINSLEY, SECRETARY AND TREASURER
Formerly Treasurer, the Standard Oil Company

Will it be one of competition or of co-operation? It is necessary, therefore, in the first place, to review the conditions of the world's commerce and industry which called the American International Corporation into existence.

The engineering profession in America is for the most part well acquainted with the difficulties and problems that attend the launching of a new industrial enterprise in a foreign country, in South America, for example, or in the Orient; how difficult it is to obtain capital for the enterprise in the first place; how next to impossible it is for an American interest to get adequate banking facilities; the lack of adequate means of transportation; the difficulty of ascertaining the exact value of the property; the lack of a steady market for American products needed for the enterprise; and finally the difficulty of keeping up the interest.

Speaking about this phase of the work of the new company, Mr. Stone, its president, said: "We are far behind the English in building up foreign trade through association with foreign people and study of their ways. The English have their young men scattered the world over. Ours have stayed at home, or, when they have ventured forth, have not had the time or the disposition for intensive study of the customs, manners, and business of foreign people.

"The field is the whole wide world. We have hardly begun to do business

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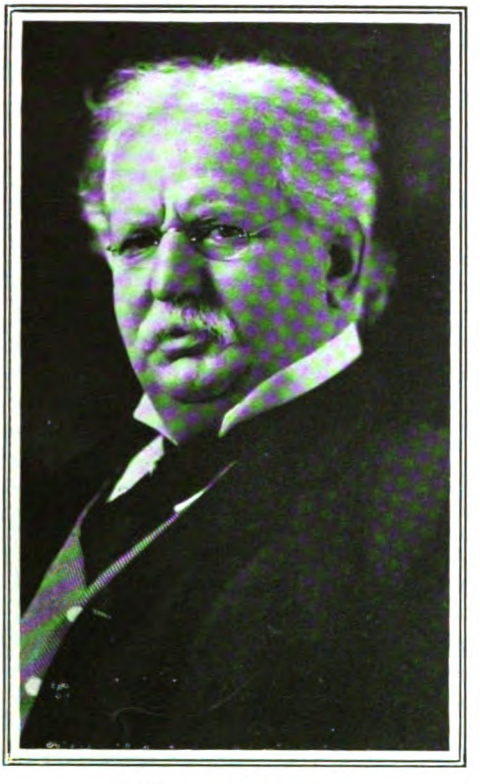

THEODORE N. VAIL
President, the American Telegraph & Telephone Co.

WILLIAM L. SAUNDERS
Chairman, the Ingersoll-Rand Company

and our office staff is not even organized, yet we have proposals before us for investment in Central America, South America, China, and South Africa. Every one of these propositions implies the employment of Americans and the purchase of American goods."

The story of the mining enterprise promisingly launched in Latin-America only to be abandoned some months later for lack of capital is familiar to American engineers. There are only too many instances of it. Another story just as familiar is that of the enterprise regretfully abandoned because the original valuation was not an accurate one. On the other hand we have seen the difficulties encountered by the American manufacturer of engineering products who tries to open up a market in South America. They were well set forth in a recent number of THE ENGINEERING MAGAZINE by Mr. Alex. Del Mar, president of the Latin-American Chamber of Commerce. The American agent does not understand the customs, often does not understand even the language of the country into which he seeks to thrust his goods. He finds a credit system impossible because there are no American banks to handle it for him; most important of all, perhaps, the American agent must report home that an extensive market is out of the question because the shipping facilities are not sufficient to maintain it.

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All these difficulties existed prior to the outbreak of the European War, but since then there has come about a new condition which has made all the former troubles seem of slight importance. The great and pressing problem in the field of foreign trade and foreign industry today is the problem of where to get the capital. Prior to the war, Europe was the chief source of liquid capital for foreign enterprises. Germany financed the coffee crops of Central and South America. English syndicates financed the railways and a great part of the mining enterprises. British and German capital financed the public utilities projects. Great Britain's liquid capital financed railway enterprises in the Orient. The number of instances might be multiplied indefinitely, but the condition was one that the American banker and the enterprising American engineer well knew—capital came from abroad.

Now the war has created a condition that might be described as a famine of capital. All the former sources of it are closed and are likely to remain dry for a long time because of the heavy financial burden which the peoples of the warring countries must bear in the shape of increased taxation and increased cost of living; the pockets from which formerly came the money to finance the enterprises in Europe, in Asia, in Africa, in South America, are now empty. The result is that many going concerns in many different parts of the world are seriously in need of capital to continue the enterprise.

Where shall they look for it? Europe, busy with her exhausting war, must give to it her entire resources. The savings of the thrifty peoples of France, Germany, England—for we must admit to our shame that they are more careful of their earnings than the Americans are—have been sucked up in war bonds or in meeting a higher scale of living due to the war. In either event—that money is gone for many years from the field of industrial investment. On the other hand, many Europeans have been forced to liquidate their valuable holdings in enterprises in South America and Asia in order to get ready cash. The result is that these enterprises, essentially sound, have been abandoned and now lie idle awaiting only the magic touch of new capital to spring into new life.

Out of this condition arises the great opportunity which has caused the creation of the American International Corporation. It is to bring new capital and therefore new life into these languishing industries. It is an opportunity that lies at America's door with an imperative call for response, the opportunity of a nation's lifetime, a summons to international service that has the aspect of destiny. This does not mean, however, that the American International Corporation is also to seize upon the industries which it seeks to resuscitate, in other words to take advantage of a period of depression to enter upon a career of commercial rapacity.

The position of the corporation is one that should be carefully understood. Its essential purpose is not that of acquisition but of resuscitation and co-operation. It seeks, as a newspaper recently put it, "to heal the war wounds of Europe," but not to take Europe's property away from it. Some apprehension may perhaps have been created among American engineering organizations which have foreign enterprises afoot by the first announcements of the incorporation of the American International Corporation in the newspapers. Some glowing terms were used,

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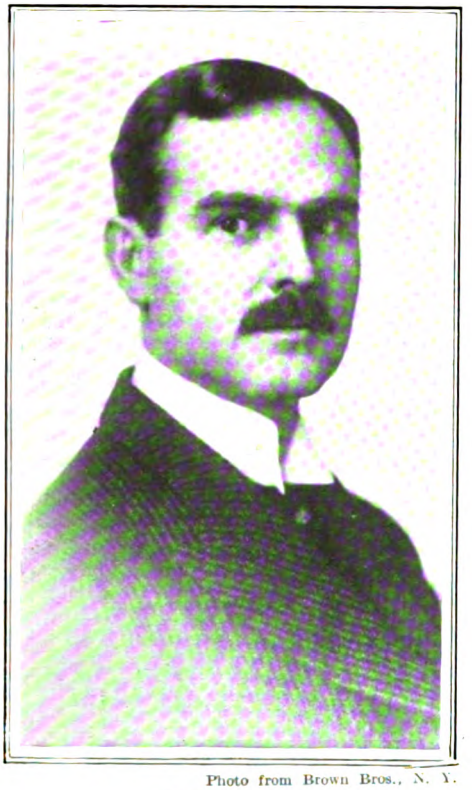

Photo from Brown Bros., N. Y.

JOHN D. RYAN
President, Anaconda Copper Company

WILLIAM E. COREY
Chairman, Midvale Steel & Ordnance Co.

truthful in substance, perhaps, but not quite accurate. The mission of the corporation was unfortunately described by one writer as "an industrial conquest throughout the world." Nothing could be less exact. The purpose is not to conquer, but to cooperate.

Underlying the work of the American International Corporation is the great hope that it will create lasting good feeling toward America and American business in foreign countries. Now, if a campaign of seizure and exploitation were planned, that would be the surest way to create not good feeling but very bad feeling, and the corporation would defeat its own ends. An excellent synopsis of the corporation's objects was given by Mr. Stone at the time of its incorporation. Attention should be directed especially to the emphasis which he placed on the idea of rehabilitation. He said:

"It is organized for the purpose of doing an international business; to promote those trade relations with the different countries which will help to make a market for our American products; to finance the promoting of great public and private undertakings in foreign countries by American engineers and manufacturers; to assist in financing the rehabilitation of industries in foreign countries; to undertake such domestic business as seems advantageous in connection therewith."

In short the purpose is to stimulate

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growth and not to acquire. Although the broad charter of the corporation enables it to hold properties, it will not do so except in emergency cases in which acquisition is necessary either to save the property from going to ruin or to keep open a means of communication. American engineers and manufacturers, therefore, should not labor under the misapprehension that the corporation would ever seek to crowd them out of a field where they had already put an enterprise under way. On the contrary, the corporation would be ready to cooperate, if called upon to do so, in the financing of the enterprise.

Let us take a mining enterprise in South America as an example. As the result of the withdrawal of European capital by the war the promoters find themselves unable to continue the development. The properties are of the highest order but the money is lacking. The enterprise is brought to the attention of the American International Corporation. What would its policy be? First, to ascertain that the enterprise was really sound. The corporation will be admirably equipped for that, because the work of determining the value of properties will be under the immediate direction of Mr. Stone, whose watchword is efficiency and economy, and who has had the very widest experience in placing enterprises on a sound financial basis. Having ascertained that the property is sound and offers a profitable field for investment the next step of the corporation would be to finance it, either through a reorganization of the company in co-operation with those interests already in charge of the properties or through an entirely new corporation formed for the purpose.

Should the conditions be such that there seemed no other way to save the enterprise except to buy it outright, the American International Corporation would do that; but in that event it would hold the property only until another organization had been provided for the continuance of the enterprise. The instance just cited might be an emergency case in which quick decisive action would be necessary at a critical moment. We had such an instance in the case of the corporation's recent purchase of the entire remaining fleet of the Pacific Mail Steamship Company, consisting of seven vessels operating between the Pacific Coast of the United States and the West Coast of Central America.

"That is the only real business we have done," Mr. Stone remarked. "We propose to keep the ships under the American flag, and, because of appeals from a great number of persons and organizations on the Pacific Coast, we will retain all but one of them in the coast service between Pacific ports in this country and Central America."

The condition that gave rise to this purchase was clearly an emergency. The Pacific Mail Steamship Company had, several months before, declared its intention of selling its entire fleet. It had already sold to the International Mercantile Marine its four large transpacific steamships—the Manchuria, the Mongolia, the Siberia, and the Korea. The breaking up of the rest of the fleet would have meant the disappearance of the American flag from the Pacific Ocean, and at the same time the loss of the only means of transportation between the Pacific Coast ports of the United States and those of the West Coast of Central America.

The American International Corporation saw that unless it acted an important means of transportation would be lost, and consequently all

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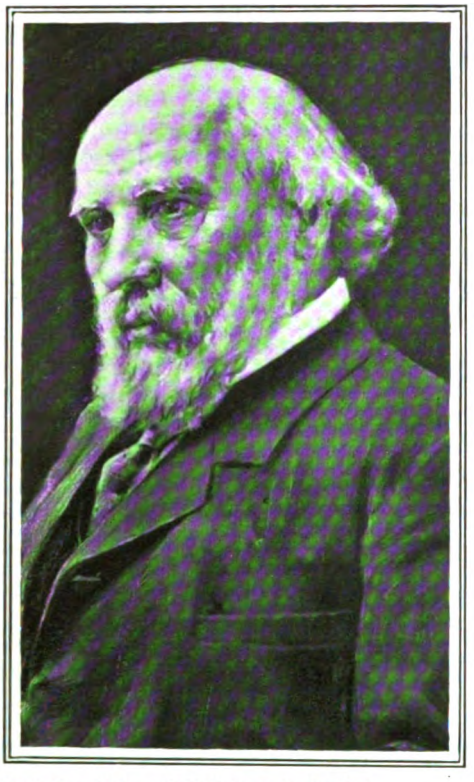

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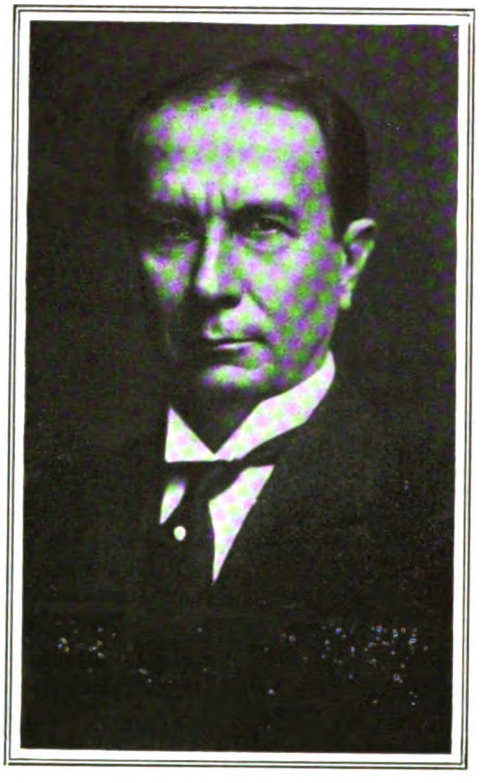
JAMES J. HILL
Great Northern Railway Company



ROBERT S. LOVETT
Chairman, Union Pacific System

trade relations between our Pacific ports and Central America. Now, the American International Corporation is not designed to be a ship-owning nor a ship-operating enterprise, but in order to keep these shipping facilities intact it had to acquire the rest of the Pacific Mail fleet. The Corporation, however, will not operate the vessels, as it has obtained the co-operation of W. R. Grace & Company, who have had wide experience with South and Central American shipping, and who will manage the line as it was before.

The attitude of the American International Corporation toward all industrial enterprises in foreign countries will be one of friendly sympathy and co-operation, being ready at all times to furnish encouragement, information, banking facilities, communication, transportation, and capital wherever they are shown to be needed. In such a way it hopes to create a spontaneous demand abroad for American-made products and to open up and keep open the avenues of trade through which those goods may freely flow.

The Government's attitude toward this new enterprise has so far been one of friendly interest. The Bureau of Foreign and Domestic Commerce of the Department of Commerce has shown an active interest, and the Federal Trade Commission is entirely in line with the progressive idea advanced by the inauguration of the corporation.

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HANDLING MATERIALS IN MANUFACTURING PLANTS

By Robert L. Streeter

IV. HOISTS

In this series, which began in our November issue, Mr. Streeter's effort has been to describe the numerous types of mechanical devices for handling material in its various stages of manufacture through the shop. Foregoing chapters have been: first, equipment for unloading bulk material in the factory yard; second, the types of cranes used within the shop; and third, belt, flight, apron and bucket conveyors for transporting smaller material. Following chapters will describe types of elevators, trucks and carrier systems for use in factories and shops.—THE EDITORS.

FROM the earliest periods of which we have historical records one of man's greatest problems has been to lift heavy loads rapidly and efficiently. Some of the greatest monuments of antiquity were built under conditions that involved lifting of heavy pieces of building material to great heights, but how it was done we do not know to this day. The manner in which the great stones were raised to their places in the pyramids in Egypt has always been a mystery and probably always will be. It is certain, however, that the builders of these wonderful monuments were possessed of mechanical contrivances that were lost in the dark ages intervening between their time and ours, or they possessed patience to a more remarkable degree than is exhibited in any race of men at the present time.

There are at least three crude methods which have been used and are still used to a slight extent for raising heavy weights. They are the lever or crow-bar, inclined plane or wedge, and the single pulley. The lever is used for lifting weights through very small distances, and the limit of the weight to be so raised depends only on the length of the lever available and the fulcrum obtainable. Thus, with a perfect fulcrum, a man who can exert a force of 200 pounds may raise a ton with a lever, but the height to which the ton may be raised is only one-tenth the distance through which the force must move, and the force arm of the lever must be ten times the length of the weight arm.

The wedge or inclined plane may also be used for lifting heavy weights small distances. In leveling up heavy machines, wedges are frequently used and they serve their purpose very well indeed. The single pulley may be used to hoist a weight any distance, but its great disadvantage is that the force exerted to raise the weight must be equal to that weight. This fault may be overcome by using several pulleys and several strands of rope, a combination which is very familiar and which is known as the block and fall. Both the block and fall and the lever have one serious disadvantage, they will not sustain the weight after it is lifted.

In the modern manufacturing plant many devices are used for doing the work which could be accomplished in a very crude and uneconomical manner by the lever, wedge, or pulley. Among them are the windlass, power-operated or hand-oper-

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ated geared hoists and inclined or vertical elevators. The windlass and the hoist are used for lifting loads short distances, such as putting work on machines and taking it off, or piling and tiering boxes, barrels, and packages in storage. Elevators are generally used for conveying material from one floor to another in factories. It is the purpose of this paper to illustrate and describe some of these machines and point out their usefulness in the modern factory.

A type of portable windlass crane is shown in Figures 1 and 2. The wheels upon which the crane is mounted make it possible to move the crane from place to place for serving different machines and to move it as well while supporting a load. The windlass is worked by hand through a pair of spur gears. The power of the hoist is doubled by passing the chain from the windlass over three guide pulleys and through a block.

FIG. 1. FLOOR CRANE WITH HOIST HANDLING WORK FOR PLANER.
The Canton Foundry & Machine Company

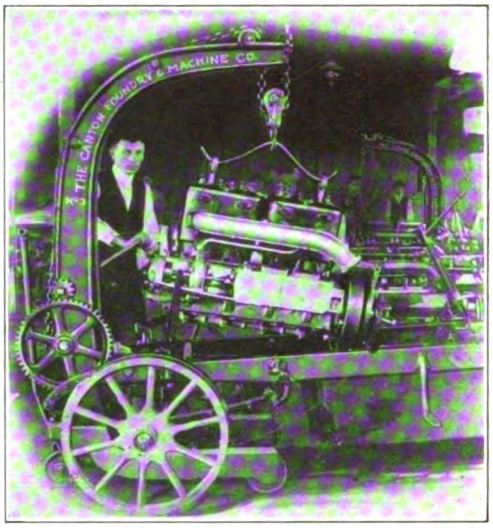

FIG. 2. FLOOR CRANE AND HOIST LIFTING MOTOR OUT OF AUTOMOBILE.
The Canton Foundry & Machine Company

The hoists illustrated have only one set of spur gears, but the manufacturer, the Canton Foundry and Machine Company, also makes a back geared type, indispensable when one man must lift 6,000 pounds or over.

These machines are made in sizes ranging from 2,000 to 8,000 pounds capacity, while the lift varies from 4 feet 6 inches to 11 feet 3 inches and the overhang from 2 feet 3 inches to 4 feet 9 inches. There are two types of truck furnished with this hoist, the regular bed, 12 inches high, shown in Figure 1, and the low type, $6\frac{3}{4}$ inches high, shown in Figure 2. The regular crane bed pulls easier than the low type on account of its $10\frac{3}{4}$-inch wheels, but there are places where the low type can be used to a better advantage than the regular type.

About fifty years ago, Thomas Weston, of Birmingham, introduced a device which has been and still is widely used for hoisting loads through comparatively short heights. This device is the differential chain hoist, illustrated in Figure 3. It is

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very simple in construction, consisting of a double sheave at the top and a single one at the bottom, with an endless chain and the necessary hooks and yokes. The theory of the hoist is this: the two upper sheaves are made in one piece, that is, they turn together on their shaft, but one sheave is larger than the other and has one more pocket, or one more tooth, as it were. The endless chain travels up over the smaller upper sheave, down around the lower sheave, back over the large upper sheave, and hangs down in a loop before going back to the small upper sheave, the starting point. The free loop of the chain may be called the power loop, as that is the portion pulled by hand in operating the hoist. By pulling this free loop on the side hanging from the large upper sheave, the chain to the lower sheave from which the load is suspended is shortened one link for each revolution of the upper sheave and the load is raised a distance equal to one link of the chain. If the other side of the loop is pulled, the load is lowered by the reverse action.

The dimensions of standard differential chain hoists are given in Table I. These dimensions are almost identical for three different makes of hoists.

Another type of chain hoist is that in which the load sheave is driven by a hand-chain sheave through a worm and worm wheel. This type is commonly known as the screw hoist. The one manufactured by Edwin Harrington, Son and Company, of Philadelphia, is shown in Figure 4. The hand-chain sheave is mounted on the overhung end of a steel screw or worm which drives a bronze worm wheel. This worm wheel is carried between two load chain sheaves. Thus, the load hook is supported by two distinct independent chains. The data referring to

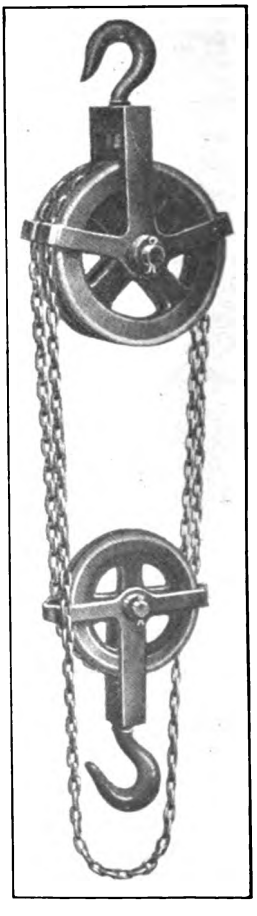

FIG. 3. DIFFERENTIAL TYPE OF CHAIN HOIST

TABLE I

DIMENSIONS OF DIFFERENTIAL HOISTS

Capacity in Pounds	Regular Hoist in feet.	Minimum distance in inches between hooks.	Net weight in pounds	Chain pull in pounds	Feet of chain to hoist load one foot.
250	5	16	11	..	..
500	6	17	22	72	18
1000	7	21	30	122	24
2000	8	26	51	216	30
3000	8½	32	81	246	36
4000	9	39	122	308	42
6000	9½	44	180	557	38

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some of the various sizes of screw hoists manufactured by the above company are given in Table II.

The advantage of the screw hoist over the differential type may be seen by a comparison of the last two columns of Table II. Selecting the 4,000-pound hoist in each case, we find that the chain pull necessary to lift the full load with the differential hoist is 308 pounds, while the corresponding figure for the screw type is 129 pounds. The amount of chain necessary to overhaul in the differential hoist in order to lift the load one foot is 42 feet, while in the screw hoist it is 93.5 feet. The efficiency of the hoist is found by the formula

$$E = \frac{100\,C}{PL}$$

Where E = Efficiency in per cent,
C = Capacity of hoist in pounds,
P = Chain pull in pounds to lift capacity load,
L = Feet of chain overhauled to lift load one foot.

The efficiency for the two types under consideration is almost the same, being 30.9 per cent for the 4,000-pound differential and 33.2 per cent for the screw type.

There are other considerations that might enter into the selection of a hoist. The weight of the hoist itself would be a factor if the hoist were to be used in different places. The differential type is lighter than the screw type as a rule, the difference being greater in the small sizes than in the larger ones. The weight of the 1,000-pound differential is 42 per cent of the weight of the screw type of the same capacity. In the 4,000-

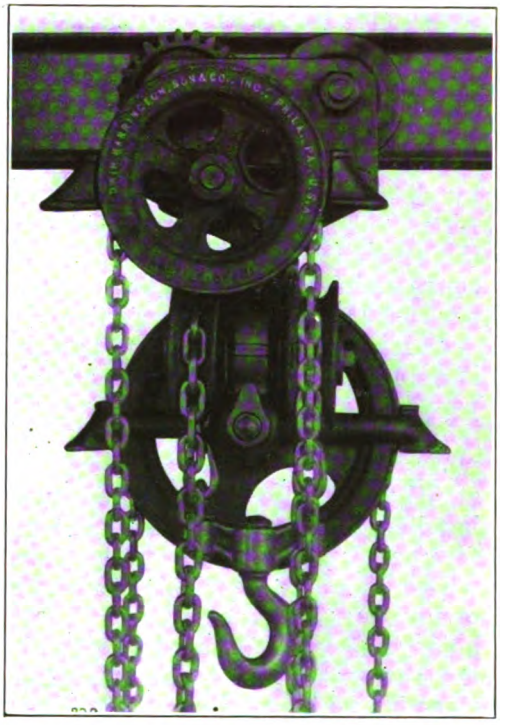

FIG. 4. SCREW TYPE OF CHAIN HOIST.
Edwin Harrington Son & Co.

TABLE II
DIMENSIONS OF SCREW HOISTS

Capacity in pounds.	Regular hoist in feet.	Minimum distance in inches between hooks.	Net weight in pounds	Chain pull in pounds	Feet of chain to hoist load one foot.
1000	8	17	71	49	60.5
2000	8	18	78	71	76.0
4000	9	22	167	129	93.5
6000	10	30	250	163	96.0
8000	10	32	329	190	128
12000	12	39½	557	293	110
20000	12	47	789	358	198
30000	12	51¾	1159	424	296

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pound size the differential weighs 73 per cent as much as the screw hoist. In the 6,000-pound size the relative weights are about as in the 4,000-pound size.

Judging from the list prices given by different manufacturers the differential hoist is a trifle cheaper than the screw type, ranging from 10 per cent less in the lighter hoists up to 20 per cent less in the heavier ones.

Considering the points brought out it appears that the differential hoist would be selected where the loads to be lifted are comparatively light and where the hoist is not to be used constantly. This type is light and easily handled. It is simple, as there are few parts; so, it is a desirable hoist where men are available for emergency or occasional work. For a hoist that is to be used frequently, the screw type is to be preferred, since it requires fewer men in lifting heavy loads than the differential.

There is still another type of chain hoist that has been developed for lifting heavy loads more efficiently than either of the types already described. This type uses a planetary system of spur gears, and is named by different manufacturers, "Triplex Block," "Peerless Hoist," "Tribloc," etc.

Its action may be understood by referring to Figure 5, which shows a Yale Triplex Block with the gear-case cover removed. The small central pinion *B* is keyed to the same shaft as the hand-chain drum and turns with it. This small pinion turns the two planetary gears shown in the illustration. These planetary gears are each integral with a concentric pinion which meshes with a stationary annular gear in the case of the hoist. Thus the planetary gears with their oval frame turn about the central axis but at a much slower rate than the central pinion. These planetary gears and frame are attached to the load chain drum which revolves with them. In the Triplex one-ton hoist it is necessary to turn the chain drum and central pinion eight and one-half revolutions in order to turn the hoist drum through one revolution.

Table III gives the data on Harrington Peerless Hoists, similar to that given in Tables I and II for the differential and screw types.

The marked advantage of the planetary gear type of hoist may be seen by a cursory examination of the last two columns of Table III and a comparison of the figures in those col-

TABLE III

DIMENSIONS OF PEERLESS HOISTS (PLANETARY TYPE)

Capacity in pounds.	Regular hoist in feet.	Minimum distance between hooks in inches	Net weight in pounds	Chain pull in pounds	Feet of chain to lift load one foot.
1000	8	14	62	64	20.3
2000	8	16	84	81	31.5
4000	9	22¼	157	124	40.5
6000	10	24	236	130	59.0
8000	10	29	230	128	81.0
12000	12	34½	359	134	118.0
20000	12	42	533	181	154.5
30000	12	55¼	995	208*	103.0*
40000	12	62¼	1260	186*	154.5*

* On each of two hand chains.

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umns with the figures given in the corresponding columns of Tables I and II. In making the comparison we find that the differential hoist is the most rapid of the three. Glancing at the 6,000-pound size, we see that it is necessary to overhaul 96 feet of chain in the screw hoist to lift the load one foot, 59 feet in the planetary gear hoist, and only 38 feet in the differential. Thus, as far as speed is concerned, we might class these hoists as follows: First, differential; second, planetary; third, screw. Investigating the chain pull necessary to lift the full load, we find that, for the 6,000-pound hoist, the planetary stands first with 130 pounds, the screw second with 163 pounds, and the differential third with 557 pounds, which is 3.41 times that required for the screw type and 4.28 times that required for the planetary type.

In the matter of efficiency, the planetary type shows a marked advantage over the other two. It has already been shown that the efficiencies of the differential and screw types in the 4,000-pound size are 30.9 and 33.2 per cent, respectively. The efficiency of the 4,000-pound planetary type is 79.6 per cent. These efficiencies, which were computed by the writer from the values given in the last two columns of Tables I, II, and III, check very closely with the results which are being obtained in the Hoist Laboratory of the Rensselaer Polytechnic Institute.

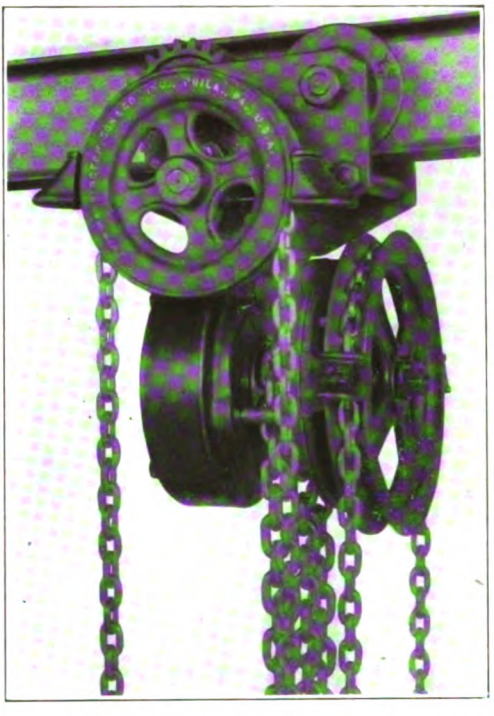

FIG. 6. HARRINGTON "PEERLESS" HOIST MOUNTED ON TROLLEY. BOTH HOIST AND TROLLEY ARE OPERATED BY HAND

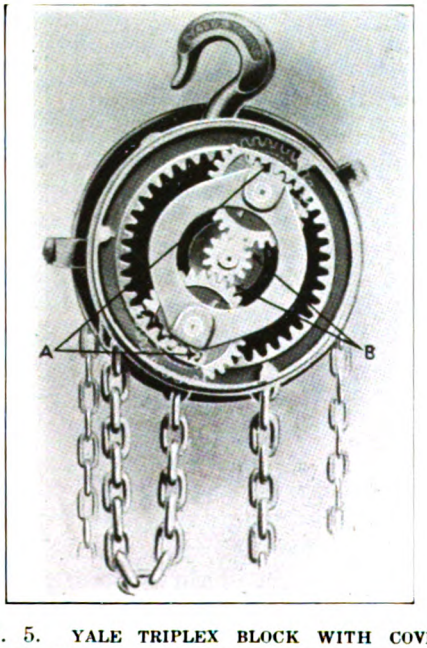

FIG. 5. YALE TRIPLEX BLOCK WITH COVER REMOVED SHOWING PLANETARY GEARING

The superior efficiency of the planetary type of hoist, the fact that it is lighter than the screw type and only slightly heavier than the differential, and also that its cost is only slightly in excess of the others, make it not only suitable but indispensable where the hoist is to be used continuously or frequently.

There is one point in which the

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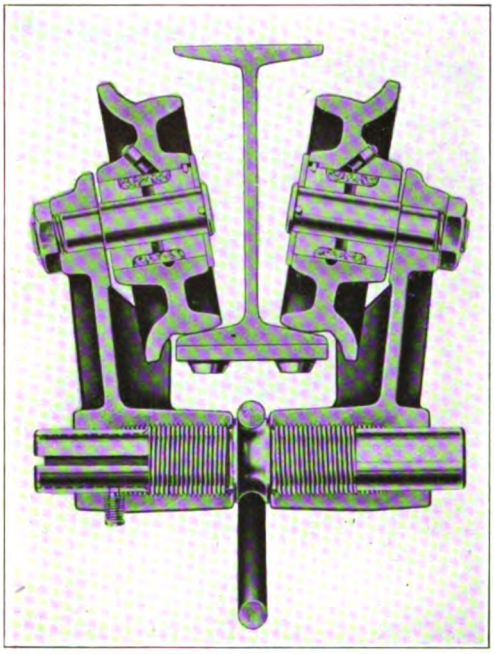

FIG. 7. SECTION OF TROLLEY USED WITH HOISTS
Curtis Pneumatic Machinery Company

planetary hoist differs from the differential and screw types that makes it a little more expensive to build. The two latter types hold the load suspended in any position without a brake of any kind. It is a well known fact that a worm and worm wheel gearing may be turned only when the worm is the driver. This in a screw hoist prevents the load from falling. The differential hoist supports its load owing to the fact that the radii of the two upper chain drums are so nearly the same that the friction of the machine is enough to overcome this difference and prevent the load from dropping. With the planetary type the case is different, and a mechanical brake must be employed to hold the load. This brake is so constructed that it is entirely disengaged when the load is being raised and thus does not increase the friction.

The hand hoists need not be used as stationary hoists by any means, but may be mounted on hand-power I-beam trolleys, as shown in Figure 6. In this particular hoist, also manufactured by Edwin Harrington, Son and Company, the endless hand-racking chain drives one of the trolley wheels through a pair of spur gears. A sectional view of the trolley manufactured by the Curtis Pneumatic Machinery Company of St. Louis, is illustrated in Figure 7. This trolley may be adjusted in width for different sizes of I-beams by means of the right- and left-hand screw which also supports the suspension link. The plain cylindrical bearings are lubricated by oil-soaked waste held in a cavity in the bearing bushing. This trolley is also built with roller bearings.

The application of the Yale Triplex Hoist to the I-beam trolley is shown in Figures 8 and 9. In the former, two men are handling large boxes in a warehouse by means of tongs. In the latter, one man is handling a heavy timber in a wood-working shop by means of hooks and a rope sling.

The various uses to which the hand-operated chain hoist may be put economically are so numerous that it would be folly even to try to enumerate them. One use which is very important is hoisting work on and off machines in the shop. Here, the differential type may be used for work weighing up to 1,000 pounds. Above that weight the hoist would require two men, and the machine operator would need assistance. With the planetary type of hoist, one man could handle work up to 8,000 or 10,000 pounds.

There are certain classes of work that can be done and often are done by hand, but which could be done economically by chain hoists if proper investigation were made to show the possibilities of using hoist power instead of hand power. As a general

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proposition it might be stated that where carriers of any kind are held up for loading and unloading, it pays to do the unloading or loading as rapidly as possible. This fact accounts for the mammoth ore docks at Duluth and other Lake Superior ports, which can load a cargo of 10,000 tons of ore in 45 minutes, and also for the expensive unloading plants at Lake Erie ports. It accounts also for the railway car dumper, the efficient wharf cranes now being installed at our ocean ports, and various other contrivances used to facilitate the loading and unloading of railway cars and vessels.

The efficient use of motor trucks and light commercial cars is made possible only where the vehicles are kept working a large percentage of the time. A table published in the *Commercial Car Journal*, February 15, 1912, showing the cost of operat-

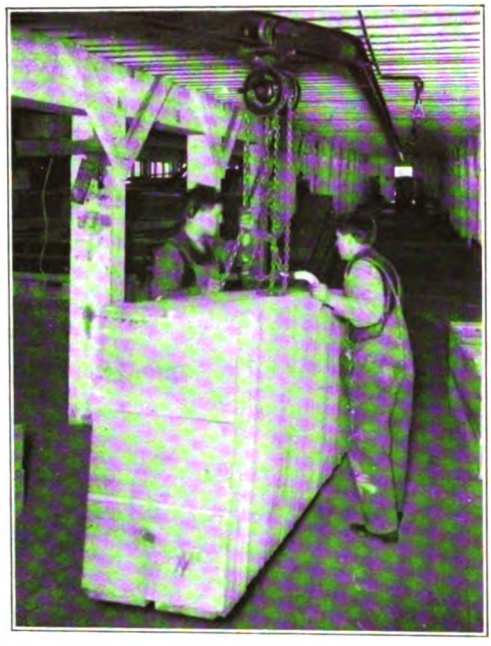

FIG. 8. YALE TRIPLEX BLOCK HANDLING BOXES IN SHIPPING DEPARTMENT

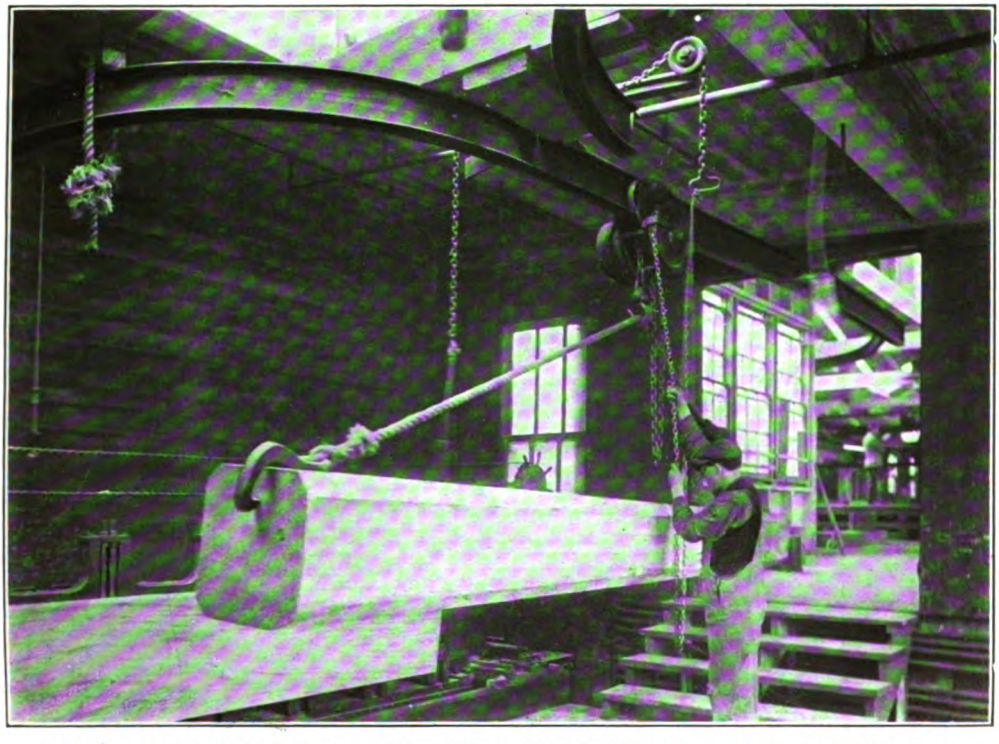

FIG. 9. YALE TRIPLEX BLOCK HANDLING HEAVY TIMBER IN A WOOD WORKING MILL

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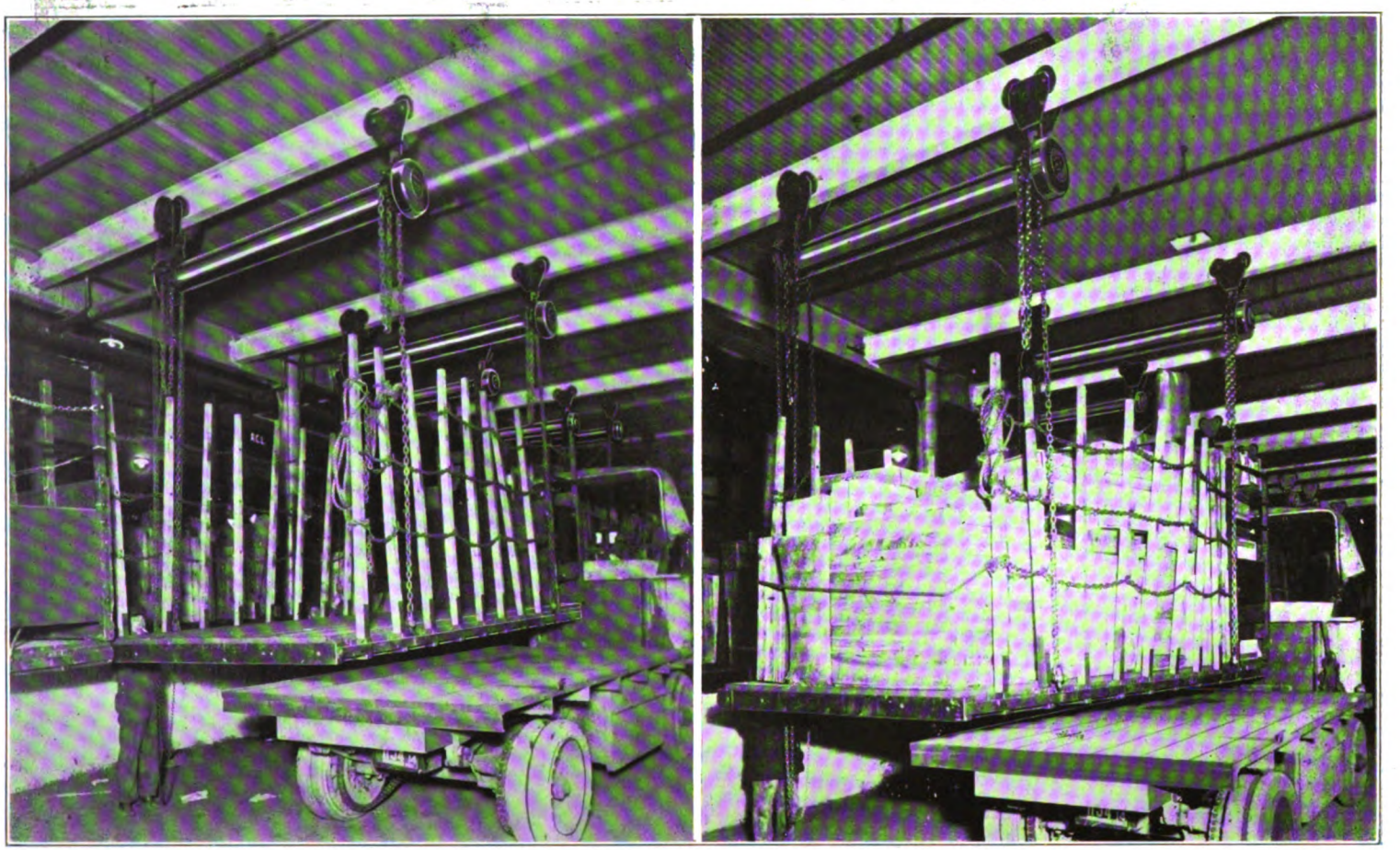

FIGS. 10 AND 11. YALE DOUBLE-HOOK TRIPLEX BLOCKS LIFTING EMPTY BODY FROM AND LOADED BODY ON A MOTOR TRUCK IN THE SHIPPING DEPARTMENT OF THE BALTIMORE BARGAIN HOUSE

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ing various sizes of trucks, illustrates this point clearly. This table shows that a three-ton truck costing $3,500 can be operated for 17.6 cents per ton mile if the full load is carried 15 miles per day or 4,500 miles per year. If the load is carried 20 miles per day, the cost drops down to 13.8 cents per ton mile; at 50 miles per day the cost is 7.35 cents, and at 100 miles per day the cost is 5.14 cents per ton mile. It is not difficult to secure the lower mileages per day, but to get 100 miles, or even 75 miles per day, the truck must be kept moving and, hence, lit-

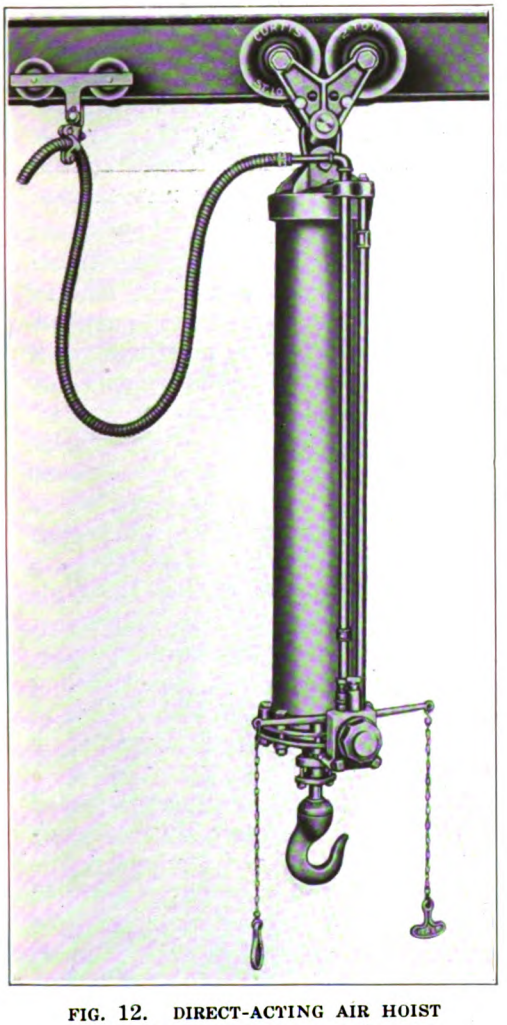

FIG. 12. DIRECT-ACTING AIR HOIST
Curtis Pneumatic Machinery Company

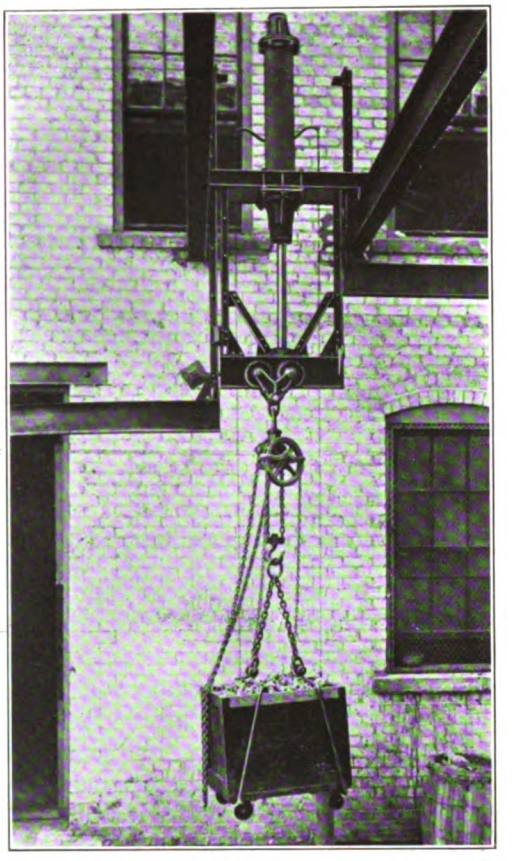

FIG. 13. CURTIS DIRECT-ACTING AIR HOIST LIFTING LOADED TRUCK TO BE DUMPED INTO WAGON

tle time can be spared for loading and unloading. When bulk material is handled, the question of loading and unloading is not a serious one, as loading may be accomplished by means of a chute and unloading by means of a dump body. When package material is being carried, the question is not so simple. Usually the packages vary greatly in size and shape, so that handling the packages one at a time is costly work. One scheme now being used to a good advantage is to have removable bodies or racks that are lifted on and off the truck at the loading and unloading points. These bodies may then be filled while the truck is making a trip.

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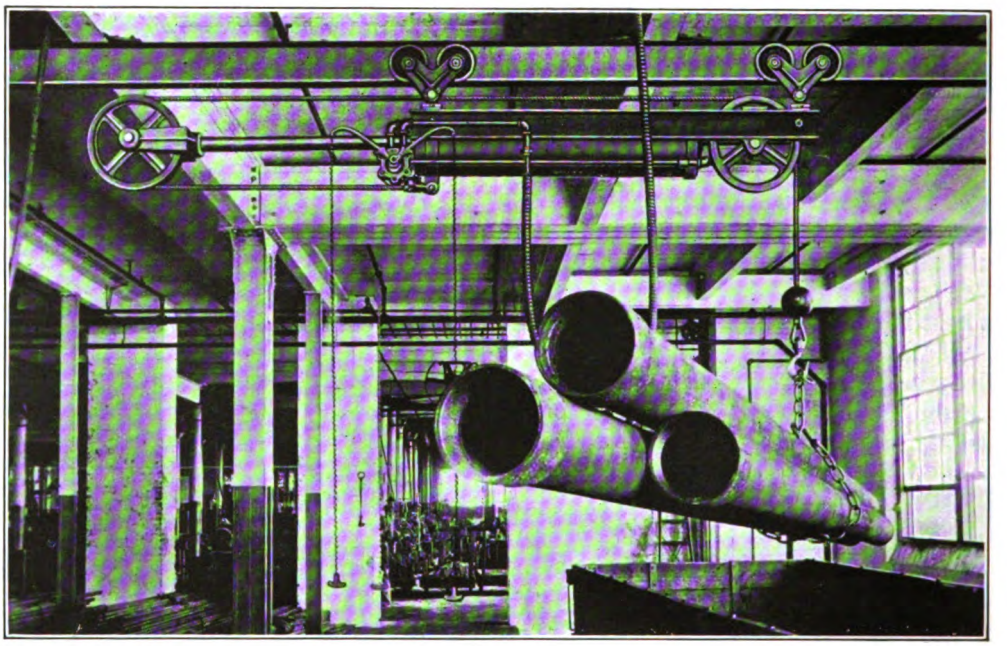

FIG. 14. CURTIS HORIZONTAL HOIST ON TROLLEY, UNLOADING PIPE FROM FREIGHT CAR

The work of lifting these bodies on and off the trucks may be accomplished quickly and at low cost by means of chain hoists. An installation of this kind has been made at the store of the Baltimore Bargain House, Baltimore, Md. This company purchased six 5-ton trucks to carry packages to the railroad stations. After using these trucks for several months, it became evident that while the trucks afforded a great convenience, the expense of installation made the investment a doubtful one, considering the amount of freight the trucks were able to handle compared with horse-drawn vehicles. After a careful study of the situation, it was decided to equip the trucks with removable bodies and install chain hoists to lift the bodies from the trucks and carry them, by means of a trolley, to the edge of the loading platform where they could be either loaded or unloaded. In the meantime another body could be put on the truck which would then drive away.

In Figure 10 is shown the stake body being picked up by the hoists and trollied over against the loading platform. The body is held suspended on a level with the platform while it is being loaded. This materially increases the platform space, and effects a saving in favor of the trucks. Figure 11 shows a body that has been loaded and is being trollied over a truck which has just been relieved of an empty body. The hoists used are the Triplex Blocks built by the Yale and Towne Manufacturing Company. They are similar to the standard one-chain hoists, the only difference being that they have two hoist chains and drums, both of which are operated by one hand chain.

Before this scheme was adopted each truck required two hours for one round trip, but after its adoption the time was reduced to one hour and five minutes. This saving amounts to 4 hours a day or 1,200 hours per year, making an actual saving of about $2,400 per year per truck. Influenced

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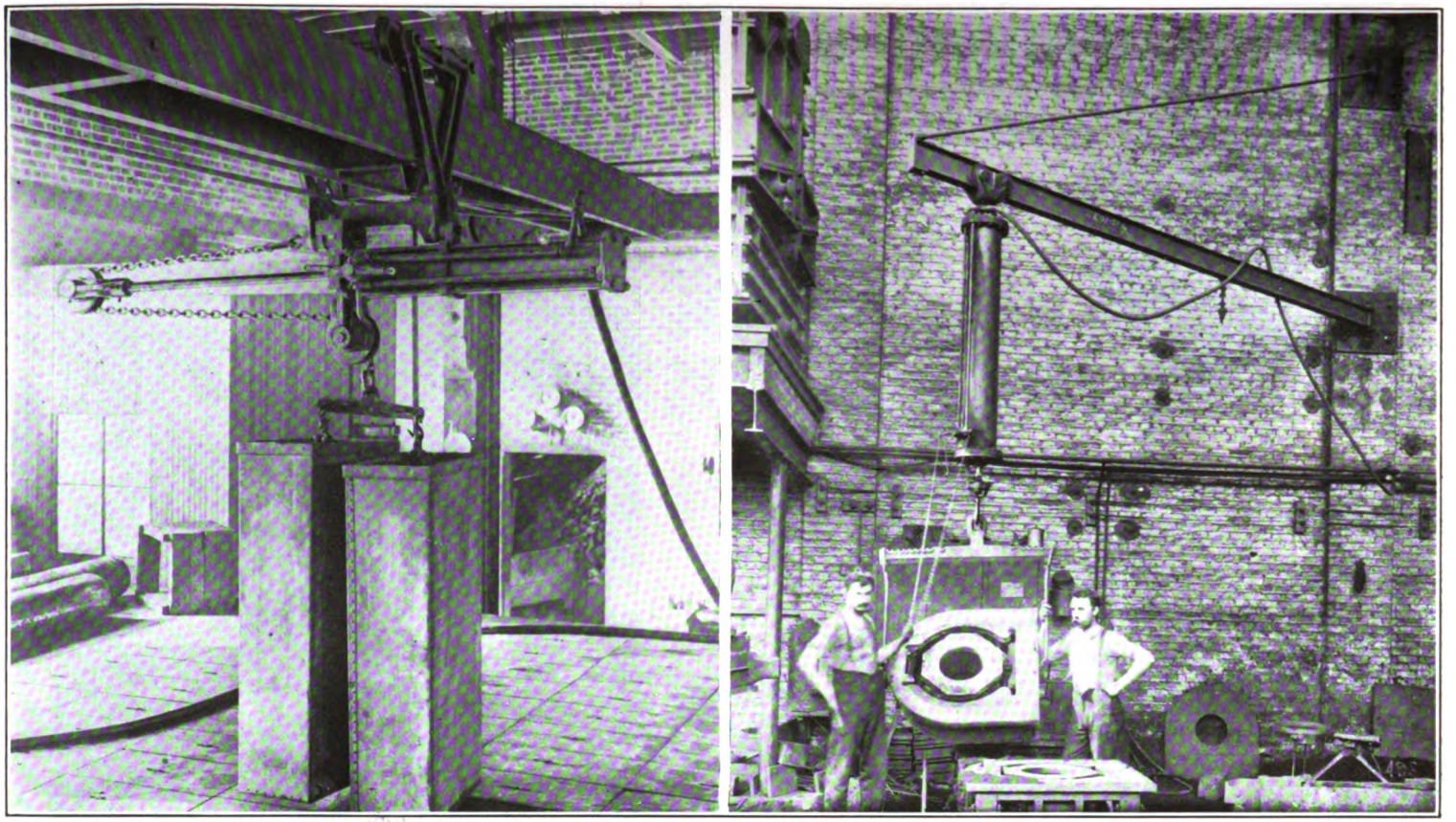

FIGS. 15 AND 16. WHITING AIR HOISTS

On the left is shown a horizontal air hoist which operates on a trolley and carries cans of block ice in an ice-making plant. On the right is a vertical air hoist attached to the end of a wall crane in a foundry

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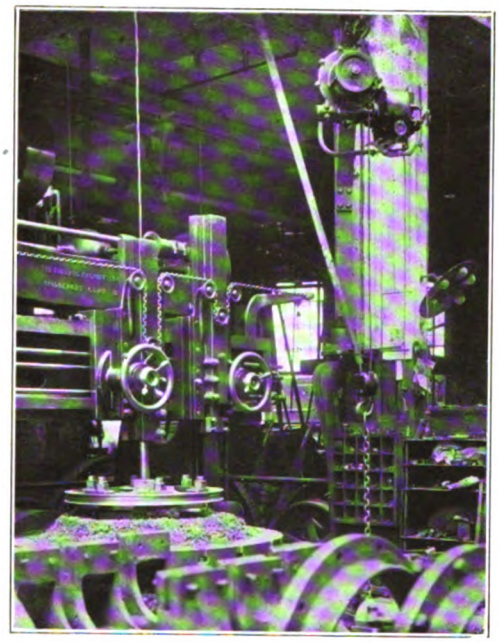

FIG. 17. "IMPERIAL" PNEUMATIC MOTOR HOIST AT THE MORSE, WILLIAMS PLANT OF OTIS ELEVATOR COMPANY

by this saving the store purchased eleven more trucks, making sixteen in all.

PNEUMATIC HOISTS

There are many places where a power-driven hoist may be substituted for the hand-operated chain hoist to a good advantage, where lifting operations are frequent and rapid, or where the lift is comparatively great. In the case of the Baltimore Bargain House installation, mentioned above, it would not pay to put in power hoists, as the number of lifts per day for each hoist is comparatively small, and the height through which each load is lifted is only a few inches. In a machine shop where work must be lifted from the floor upon a machine, or in a foundry where patterns, molds, or castings are handled, power hoists may be used to a good advantage as auxiliaries to overhead cranes.

The simplest and cheapest type of power hoist is the direct-acting compressed-air lift illustrated in Figure 12. It consists essentially of a vertical cylinder in which a single-acting piston carries a rod projecting

FIG. 18. "IMPERIAL" MOTOR HOISTS IN THE FOUNDRY OF PRATT AND WHITNEY COMPANY, HARTFORD, CONN.

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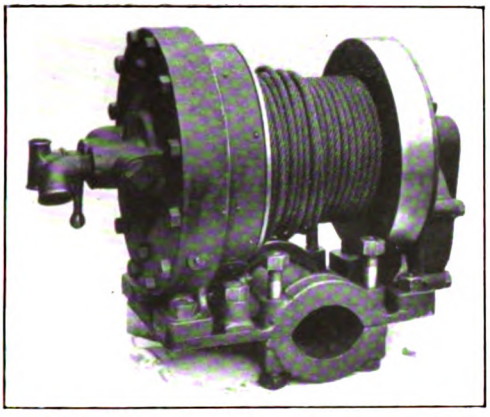

FIG. 19. INGERSOLL-RAND "LEYNER" AIR MOTOR HOIST WITH A CAPACITY OF 2½ HORSEPOWER

through the lower cylinder head by means of a stuffing box. A crane load-hook is attached to the lower end of the rod. The valve, which controls the admission of air to the underside of the piston, is operated by pendant cords. The inside diameters of the air cylinders vary from 3 to 24 inches in standard hoists, while the stroke varies from 4 to 8 feet. It is obvious that the capacity of a given hoist depends on the air pressure used. With the usual air pressure at 60 to 100 pounds per square inch, the 3-inch hoist will lift from 350 to 600 pounds, while the 24-inch hoist will lift from 24,000 to 40,000 pounds.

This hoist will hold the load in position as long as there is air at the proper pressure beneath the piston. In order to prevent the load from being dropped because of a broken air hoist, a safety check valve is usually fitted on the hoist cylinder.

One of the disadvantages of the air hoist illustrated in Figures 12 and 13 is the head room required, and to overcome this difficulty, the cylinder is sometimes placed in a horizontal position and a rope or chain is utilized to get a vertical hook motion, as shown in Figures 14 and 15. This type has several other advantages over the direct vertical type. The first is, that the lift may be doubled without increasing the stroke of the piston; another is that the high-pressure air, used for hoisting, acts in the head end of the cylinder and, hence, not on the stuffing box. The hoist must be made double acting, however, in order to force the piston back to the head end of the cylinder when there is no load on the hoist. The pressure required for this operation is small, so there is little stuffing-box trouble.

Another disadvantage of the air hoist is that its range of action is limited by the length of the air hose. This does not prevent a certain amount of mobility, however, and does not make it impossible to use

FIG. 20. THE SAME HOIST ILLUSTRATED IN FIG. 19, RAISING A 1000-POUND LOAD

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the hoist on a short-travel trolley. The hoist illustrated in Figure 16 shows an application to a wall crane for foundry work. Here, there is no difficulty in using a hose long enough, so that the hoist may cover an area that a wall crane could not possibly cover.

To overcome some of the disadvantages of the direct-acting hoist, the hoist illustrated in Figures 17 and 18 has been designed by the Ingersoll-Rand Company. The power unit is a three-cylinder reciprocating engine, or motor, such as is used on pneumatic drills and reamers. The crank is stationary, and the cylinders revolve. Air admission and exhaust is controlled by ports in the stationary crank, thereby eliminating valves. The motor is geared to the hoist drum by means of a worm and worm-wheel in the small sizes; a pair of spur gears is added in the larger sizes. As in the hand-operated screw hoists, there is no brake needed to hold the load in any position. The operating valve is of the reversing type, so the motor may be run in either direction, and is so arranged that it will close automatically when the pendant operating cords are released. There is also an automatic stop which closes the valve when the load has been raised to the top. This hoist is built in the five sizes shown by Table IV.

A type of motor, similar to that used on the hoists illustrated in Figures 17 and 18, is used on a portable hoist for "knock-about" service. This hoist is shown in Figures 19 and 20. It is entirely self-enclosed, is lubricated by a splash system, and is built with the idea that it will be used by inexperienced operators and under the severest conditions. The capacity is 1,000 pounds, with a rope speed of 85 feet per minute with air at 80 pounds pressure. The drum has a capacity of 700 feet of ¼-inch or 450 feet of 5/16-inch rope.

The Electric Hoist

Where electricity is available, the motor-driven hoist may be used to good advantage under the same conditions that make a pneumatic hoist better than the hand-operated type. The electric hoist is as superior to the air hoist as electric power is superior to compressed-air power. Motors may be applied to the same type of hoist as those using hand power. Thus, the one illustrated in Figure 21 is essentially the Yale Triplex Block with a motor connected to it by means of a chain drive. The one-ton electric hoist is made up of the two-ton hand hoist, the half-ton electric from the one-ton hand, etc.

The Yale and Towne Manufacturing Company also builds a type of electric hoist illustrated in Figure 22. In this type the load is sustained by the interlocking gearing, while in the Triplex type a brake is employed for that purpose.

Table IV

DIMENSIONS OF "IMPERIAL" MOTOR HOISTS

Capacity in pounds	Feet lift per minute, 80 pounds pressure	Maximum lift in feet	Cubic feet of free air per minute	Net weight in pounds
1000	32	20	45	270
2000	16	20	45	270
4000	8	20	45	395
7000	8	20	80	785
10000	7	20	80	785

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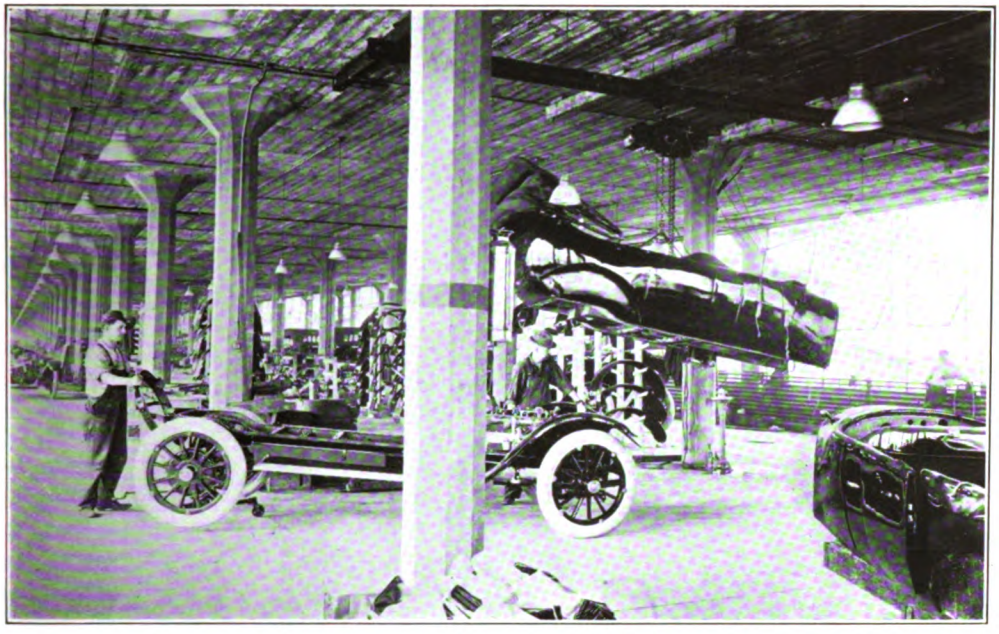

FIG. 21. YALE ELECTRIC TRIPLEX HOIST HANDLING AUTOMOBILE BODIES

Electric hoists may be obtained which use either direct or alternating current, and in either case a variable-speed control is used. The horsepower of the motor depends on the load lifted and the speed. The 1,000-pound hoist requires a one horsepower motor with a lifting speed of 21 feet per minute. This size may be and is built with different hook speeds and the size of the motor is varied accordingly. As a rule the rated capacity of the alternating-current motor would be a little greater than that of the direct-current motor for the same hoist. In the standard hoists, the hook speeds vary from 8 feet per minute in the 20,000-pound hoist to 42 feet per minute in the 1,000-pound hoist. The data for direct- and alternating-current hoists, as manufactured by Maris Brothers of Philadelphia, are given in Table V. This table is incomplete in that it lists only one hoist in each size, while there are several in each size, with variations in speed and horsepower.

In the Maris hoist, illustrated in Figures 23 and 24, the rope drum is

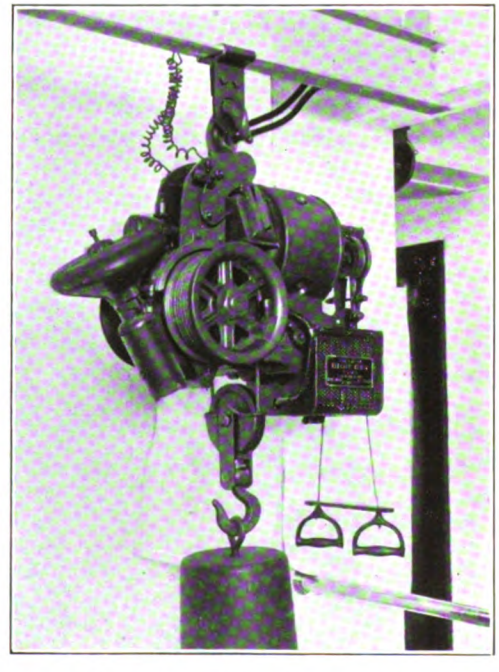

FIG. 22. YALE TYPE K-Y ELECTRIC HOISTS IN SIX SIZES FROM 1 TO 10 TONS CAPACITY

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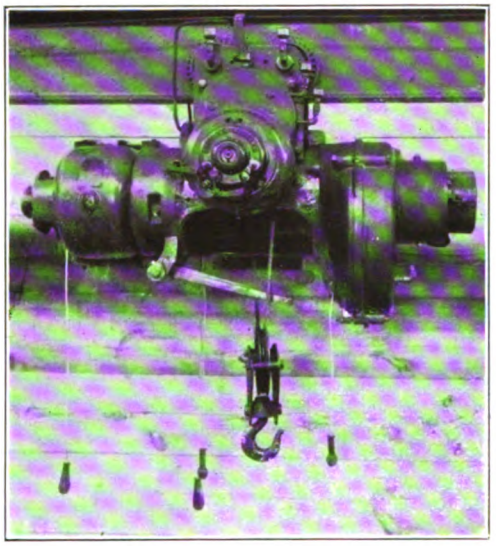

FIG. 23. MARIS ELECTRIC HOIST BUILT IN EIGHT SIZES RANGING FROM 1,000 TO 15,000 POUNDS CAPACITY

driven by the motor through a chain of spur gears. The load is held by means of a duplex brake so arranged as to be in action only in the lowering direction or when the power is cut off from the motor. This brake is a combination of the load and armature type commonly used on electric cranes and hoists. It is contained in an oil-tight case, and consists of alternate bronze and cast-iron friction surfaces which are forced into contact by the action of the load. The friction being somewhat in excess of the pull of the load, the load is prevented from running down until the brake is driven in the lowering direction by the motor. Hoisting is accomplished without driving through the friction of the brake discs, but in lowering there is always a retaining friction directly in proportion to the load handled. The brake is released by means of a solenoid magnet which is in series with the field of the motor in the hoisting direction only. When it is desired to lift the load, the controller is moved to the hoisting position which energizes the motor, releases the brake, and allows the load to be lifted free from brake friction. When the controller is thrown to the lowering position the magnet is cut out of the circuit, therefore the brake remains in action and lowering is accomplished by the motor overcoming the excess or retaining friction. In case of the failure of the solenoid to release the brake in hoisting, the only result would be an increased load on the motor sufficient to overcome the brake friction. This increased load would produce such an increase in the current as to blow out the fuse.

An automatic switch cuts off the

TABLE V

DATA ON MARIS ELECTRIC HOISTS

Capacity in pounds	Direct Current			Alternating Current		
	Hook speed, feet per minute	Horse-power	Maximum travel of hook, feet	Hook speed, feet per minute	Horse-power	Maximum travel of hook, feet
1000	42	2	40	50	3	40
2000	42	4	40	40	5	40
4000	33	6	40	30	7½	40
6000	21	6	20	20	7½	20
8000	16	6	20	15	7½	20
10000	13	6	20	13	7½	20
12000	11	6	13	10	7½	13
15000	8	6	13	8	7½	13
15000	16	12	13	15	15	13

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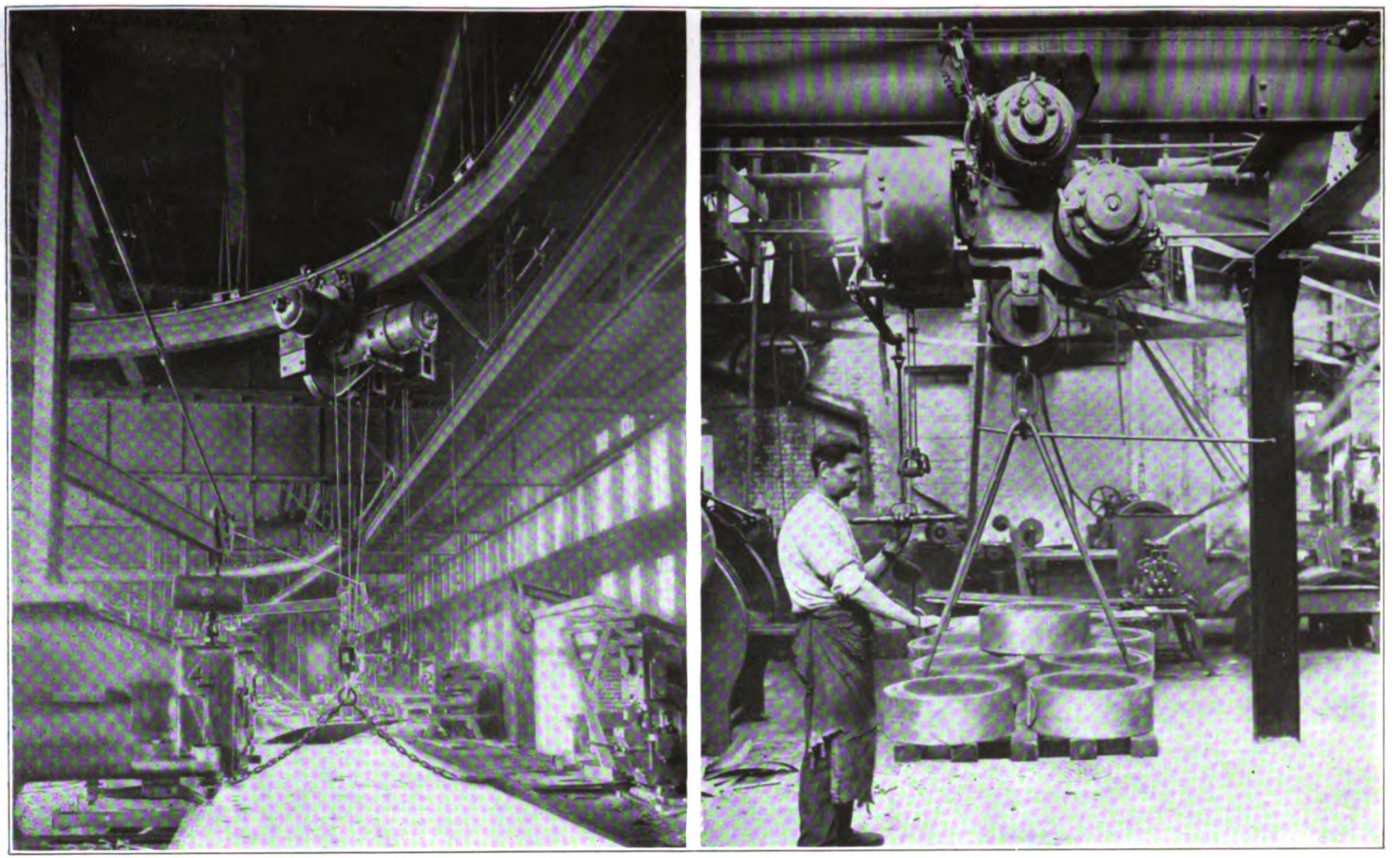

FIGS. 24 AND 25. ELECTRIC HOISTS ON ELECTRICALLY DRIVEN TROLLEYS

At the left is shown a Maris hoist operated from the floor. The 1½-ton Shepard hoist shown on the right is used for dipping rolls of strip copper in pickling tanks

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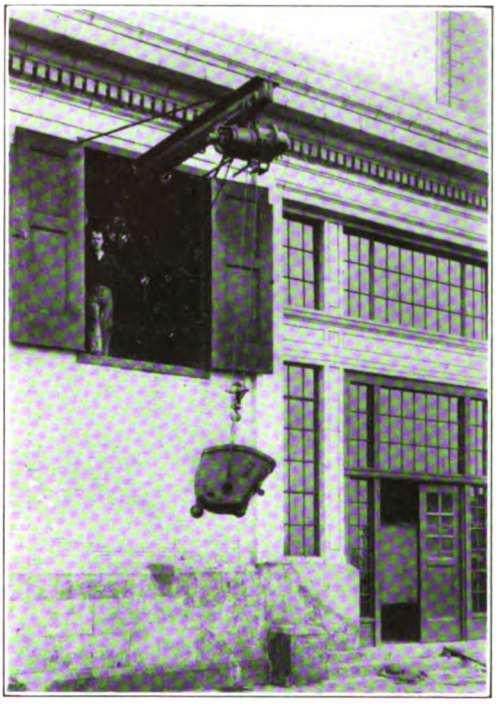

FIG. 26. ELECTRIC HOIST ON OUTRIGGER BEAM FOR HANDLING MATERIALS FROM WAGONS
Northern Engineering Works, Detroit, Michigan

current if the load is raised to the upper limit of travel. When the hook reaches a position near the drum, the switch is thrown, cutting off the current in the hoisting direction and at the same time making the proper connections so that the load can be lowered without resetting the switch. After the load is lowered a short distance, the switch is automatically reset, after which the load can be either hoisted or lowered.

The electric hoist may be used to a good advantage on overhead I-beam trolleys, as shown in Figures 24, 25 and 26. These trolleys may be operated either by hand or by motor. Where the length of the run is short, the hand operation is used, but where the distances covered are long, a trolley motor is better.

One type of electric hoist, used principally for carrying loads over comparatively long distances, is called the monorail or telepher crane. This type is distinct from the electric hoist and will be discussed in a later installment of this series.

When the trolley of the electric hoist is operated by hand, it is usually done by means of an endless chain running over a chain sheave to which is geared one or both of the trolley wheels on one side of the I-beam. The Shepard electric hoist is made in this way, as shown in Figure 27. The trolleys of the lighter sizes of hoists are often propelled by pushing or pulling on the load.

Figure 28 shows a unique application of a Shepard electric hoist in a steam radiator foundry. The pillar crane, on which the hoist is used, is portable in that it can be transferred to any bay in the foundry when the molders in that bay are working on heavy pieces. The transfer is made

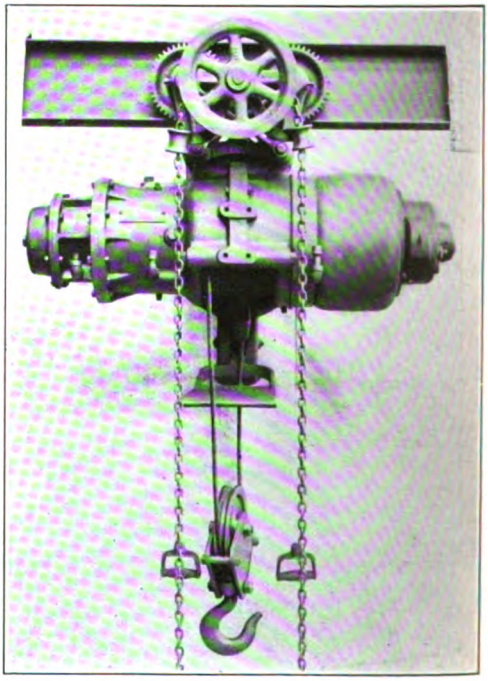

FIG. 27. SHEPARD DIRECT-CURRENT HOIST FOR HAND OPERATION. BUILT IN SIZES FROM 1 TO 12½ TONS

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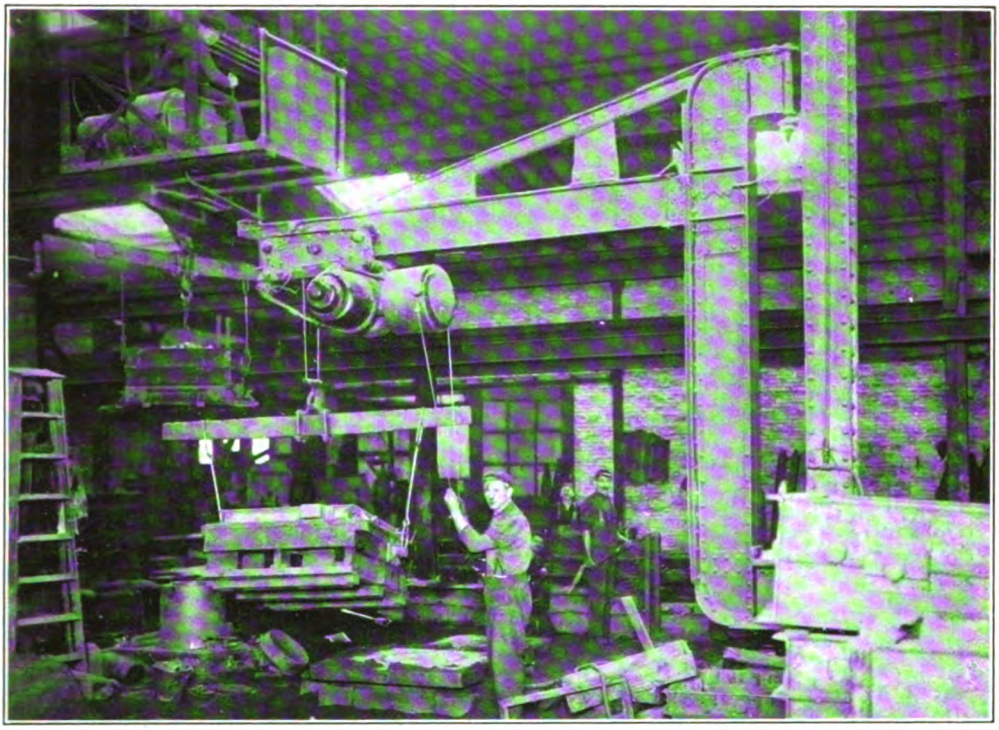

FIG. 28. SHEPARD HOIST ON PILLAR CRANE IN FOUNDRY
This crane may be moved to any bay in the foundry where it happens to be needed. Hoist is built for low head room as the hook travels nearly to the beam supporting the hoist

quickly by means of the overhead traveling crane.

HOISTING ENGINES

The term "hoisting engine" has for a long time been applied to a type of hoist composed of one, two, three, or four cable or rope drums, geared to a double-cylinder steam engine. This hoist was first developed for the use of contractors in hoisting materials by derricks on bridges and large buildings. It has been very successful for that work, and it has become so indispensable that there is a tendency to lose sight of the fact that, with a few modifications possible, it can be applied to many installations for handling material in manufacturing plants.

A hoist particularly adapted for derrick work is illustrated in Figure 29. This particular type, built by the Clyde Iron Works of Duluth, Minn., is arranged to operate three derricks; each one is independent of the others, but all may be operated at the same time. For this class of work the hoist must be strongly built in every particular and must be fool-proof in operation. The frame or the base is a rigid casting of a steel-iron mixture, and is machined to take the engine cylinder, cross-head slides, drum bearings, etc., so that good alignment will not be destroyed even under the severe usage which a hoist of this type usually gets. The gears and pinions are made of steel in the larger sizes, but in small sizes they may be made of cast iron, since the stresses are kept down to allowable figures for that material. When the pinions are made of cast iron, the teeth are shrouded on both sides for additional strength.

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the rope surface. The hard surface, due to the slight chilling effect which is present in all castings, resists the wearing action of the cable much better than if this hard surface were machined off. The bearings of the drums have bronze bushings, shouldered and keyed to prevent slipping. The friction groove and the shoulder on which the ratchet ring seats are machined.

The details of drum and friction construction are shown in Figure 30.

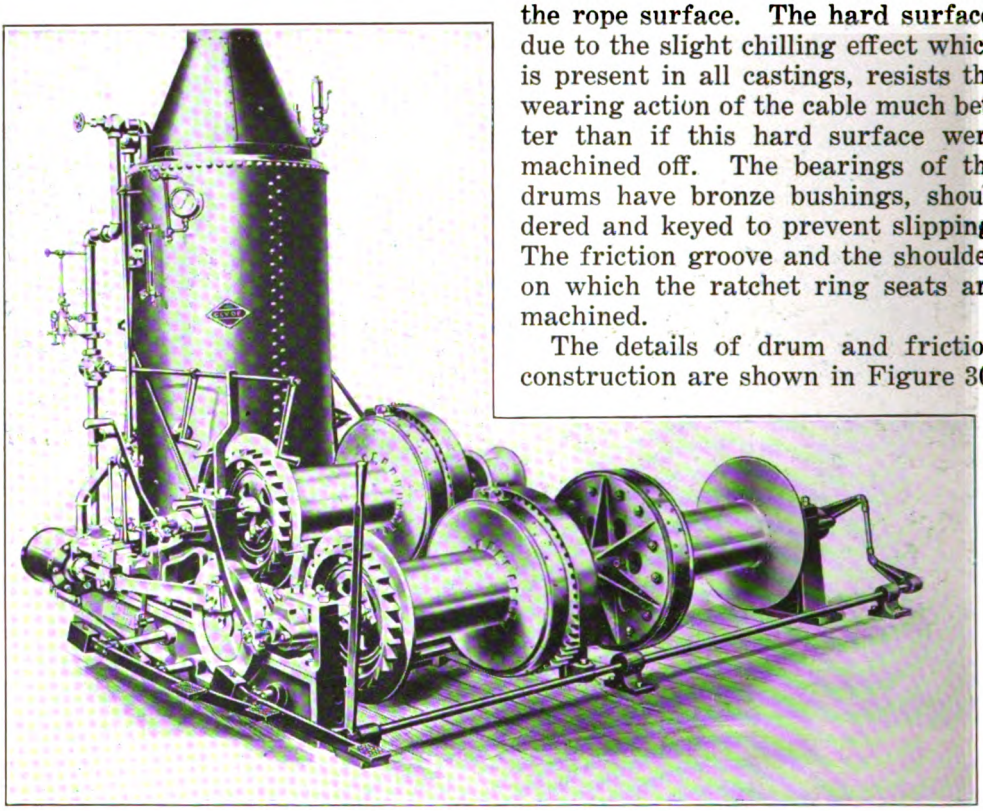

FIG. 29. WITH THIS THREE-DRUM HOISTING ENGINE BUILT FOR QUARRY WORK THREE DERRICKS CAN BE OPERATED AT THE SAME TIME
Clyde Iron Works, Duluth, Minn.

The friction drums are also made of a steel-iron mixture, cast with a smooth surface, but not machined on Friction is of the double "V" type, and is composed of long segments of hard wood secured to the spur wheel

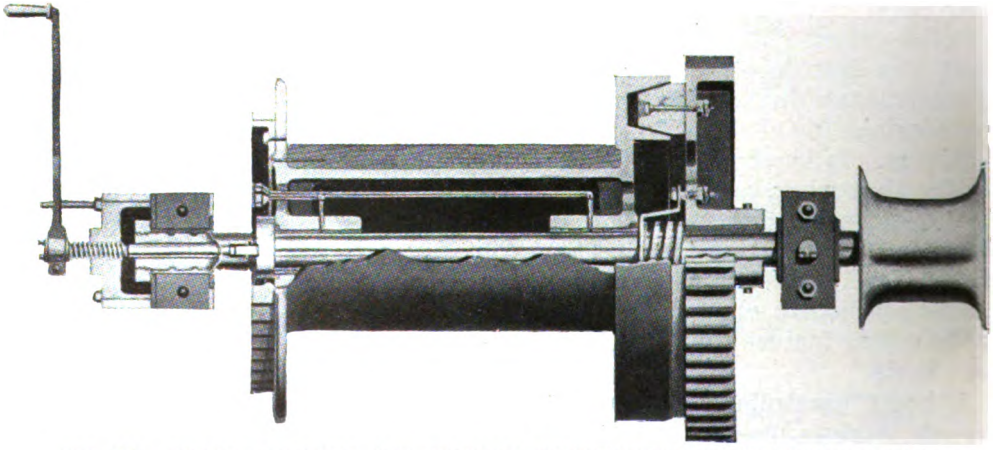

FIG. 30. DETAILS OF DRUM AND FRICTION CONSTRUCTION OF THE CLYDE HOIST

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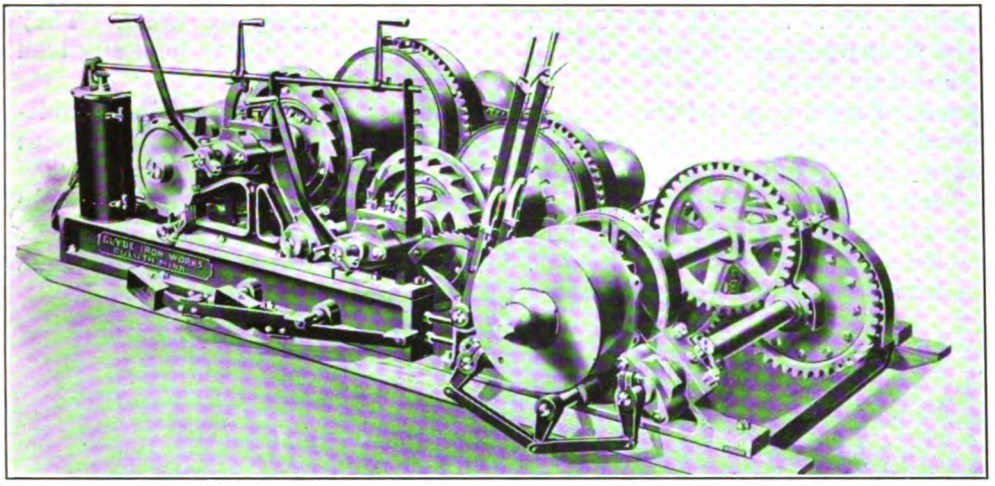

FIG. 31. TWO-DRUM CLYDE ELECTRIC HOIST WITH DERRICK SWINGING GEAR

The motor for driving this hoist may be furnished for any kind of current, with voltages of 110, 220, and 550 for direct current, and 110, 220, 440, and 550 for alternating current. Capacities range from 1,800 to 15,000 pounds

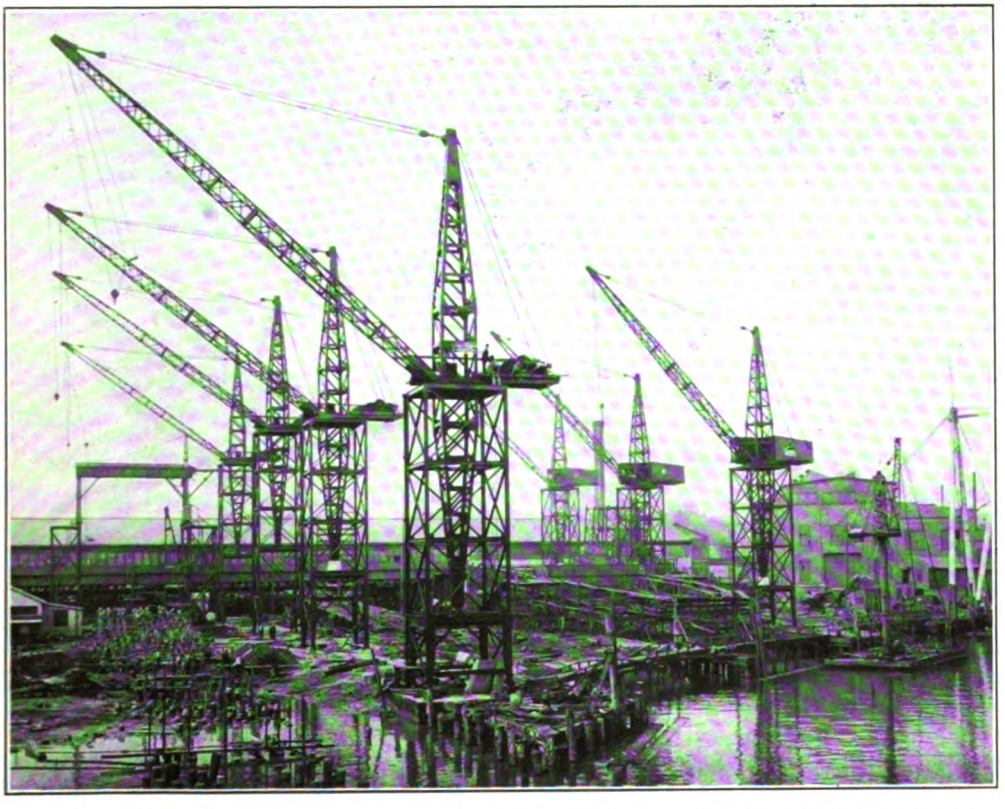

FIG. 32. SEVEN CRANES BUILT BY TERRY AND TENCH COMPANY, INC., AT THE SHIPYARD OF HARLAND AND HOLLINGSWORTH, WILMINGTON, DEL.

These cranes use a Lidgerwood electric hoist with the 70-horsepower motor shown in Fig. 33

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by bolts. These segments are turned off to fit the polished friction groove in the drum flange with which they engage. Engagement of the friction is made by means of a steel lever, friction screw, and nut at the end of the drum shaft; lateral motion is transmitted to the drum by means of a tool-steel pin, cross key, and collar. The drum is automatically released from the friction, when the pressure is removed, by means of a heavy steel spiral spring encircling the drum shaft between the drum and gear wheel. This spring is restrained by a "bridle," as shown when the friction is disengaged, so that there is no end pressure on the thrust members. This allows the drum to turn freely on the shaft when unwinding.

Brakes are provided for holding the load in check while lowering. These are contracting bands, with a single-piece lining of wood. They are powerful enough to hold any load the engine will lift.

The engine of this hoist is a double-cylinder, non-reversing type with slide valves of the "D" type. The construction is simple, as it should be when the care the engine gets, or rather the lack of care, is considered. Thus, rigid construction and simplicity predominate, instead of those refinements which might be utilized in securing a possible saving of fuel. The size of the engine, naturally, depends on the capacity and speed of the hoist. In this particular hoist, the smallest engine used is 5½ by 8 inches, and the load capacity is 4,000 pounds on a single line at normal speed, in which case the engine generates 16 horsepower. The largest engine used is 10 by 12 inches, and it generates 70 horsepower when hoist-

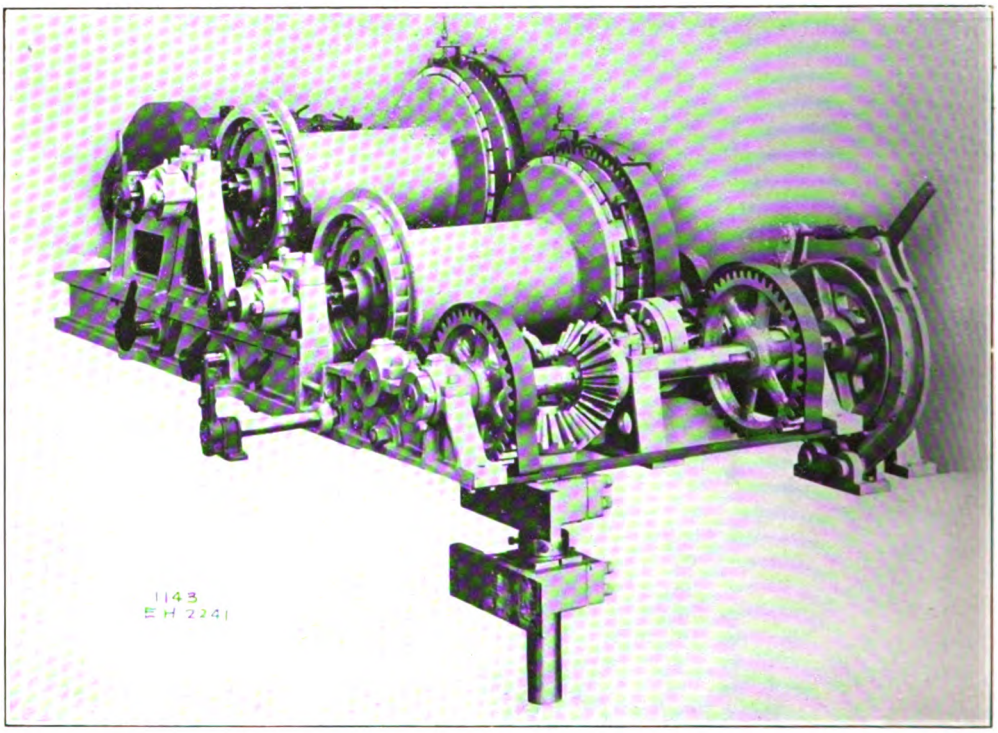

FIG. 33. LIDGERWOOD TWO-DRUM ELECTRIC HOIST USED ON THE CRANES SHOWN IN FIG. 32

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ing 13,000 pounds at normal speed.

In some localities, where electricity is available at a reasonable price, the hoist may be driven by the motor shown in Figure 31. This is a Clyde Iron Works 2-drum electric hoist with derrick swinging gear. The reversing gear is composed of the two small drums and their gearing shown to the right. The entire operation of stopping, starting, and reversing the swinging gear is controlled by one latched lever mounted on a quadrant. When this lever is in its central position, both swinging drums are stationary. When it is thrown forward, the swinging line is wound up on one drum and unwound from the other. When the lever is thrown backward, this action is reversed. Thus, the derrick may be swung in either direction. A brake is provided so that the operator may lock the drums and hold the derrick in any position.

The motor for driving this hoist may be furnished for any kind of current, with voltages of 110, 220, and 550 for direct current, and 110, 220, 440, or 550 for alternating current. The capacities of the hoists range from 1,800 to 15,000 pounds, and each size is built to operate at dif-

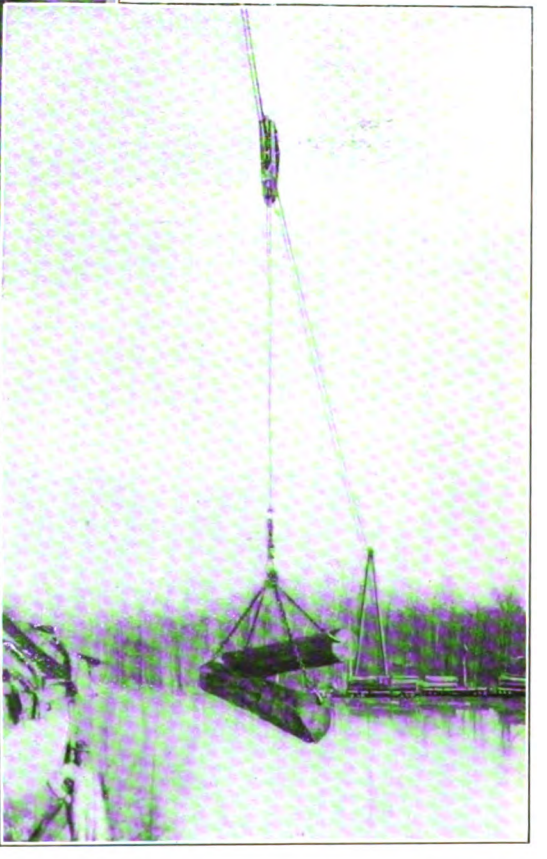

FIG. 34. TWO VIEWS OF A CABLE-WAY INSTALLED AT A SOUTHERN SAW MILL

The loads are handled by a double-drum Clyde cable-way engine similar to a hoisting engine

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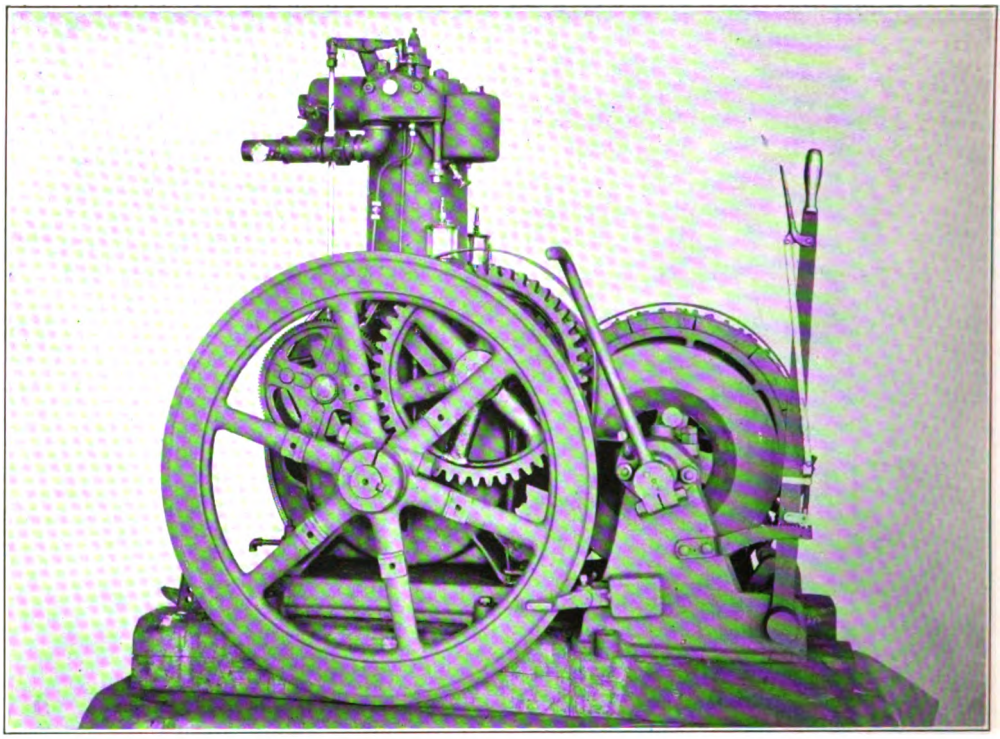

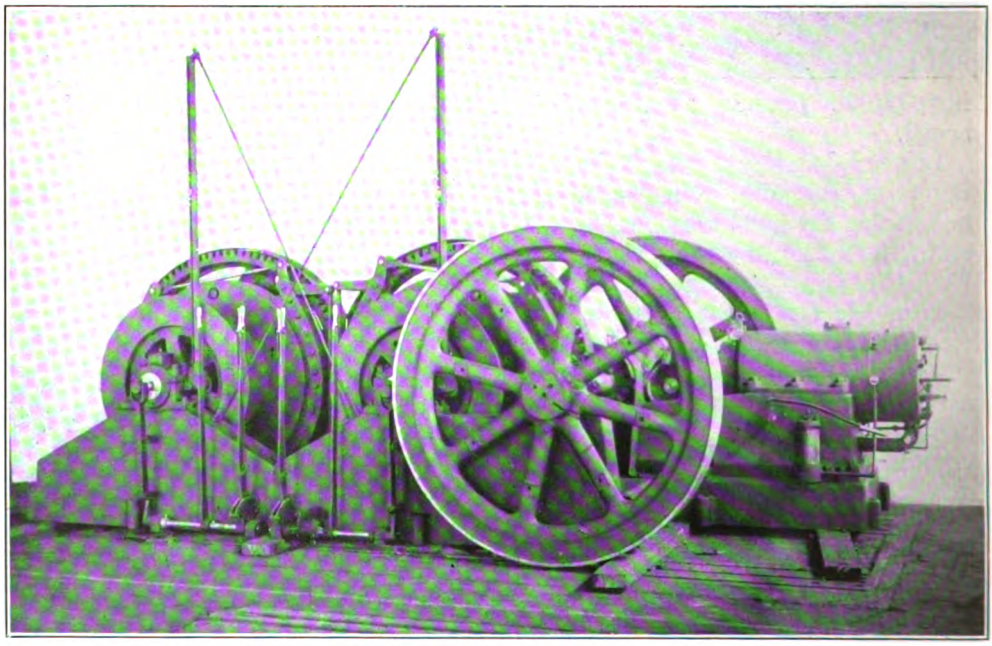

FIGS. 35 AND 36. TWO OIL-ENGINE HOISTS BUILT BY THE FAIRBANKS-MORSE COMPANY
The upper one is a single-drum hoist and is operated by a six-horsepower vertical oil engine. The lower one is a double-drum hoist operated by a sixty horsepower horizontal oil engine

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ferent hoisting speeds. Thus, the 12,000-pound hoist is made for six different hoisting speeds, ranging from 85 to 220 feet per minute, and requiring motors of 40 to 100 horsepower. This gives an over all efficiency of the hoist of 77 to 80 per cent.

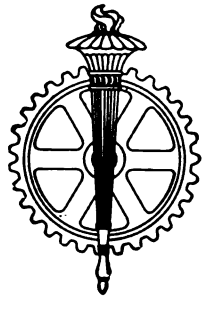
Another application of the hoisting engine is illustrated in Figure 32, which shows seven cranes built by the Terry and Tench Co., Inc., for the Harlan and Hollingsworth Corporation of Wilmington, Del. These cranes use a Lidgerwood electric hoist with the 70-horsepower motor shown in Figure 33. The drums of this hoist are 16 inches in diameter with a 30-inch fall. The usual swinging drum is omitted, and swinging is accomplished by means of a bevel gear operating the mast through a vertical shaft. The mast is rotary, located inside, and extending above the top of the tower.

The seven cranes shown are all of five-tons capacity and have a working radius of 90 feet. They vary in height, however, two being 72 feet, two 62 feet, and three 55 feet from the foundation to the level of the crane floor. The four cranes shown to the left handle material for two boats, while the three to the right may serve only one.

One application of the hoisting engine to handling materials is shown in Figure 34. This is a cable-way used for carrying logs across a river from cars to the mill. The engine is a two-drum type, similar to a derrick engine except that it is made reversible. One drum is used for hoisting, and the other for conveying the load. Conveying is done by means of an endless cable.

In some cases it is not convenient to use either steam or electricity for hoisting when internal combustion engines are available. Figures 35 and 36 show two types of oil-engine hoists built by the Fairbanks-Morse Company. Figure 35 shows a single-drum machine with a vertical six-horsepower engine, while Figure 36 shows a two-drum hoist with a sixty horsepower horizontal engine.

To be continued



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PROJECTED UNION DEPOT FOR ST. PAUL

"GILDED STAIRS AND MARBLE HALLS"

By Reginald Gordon

The people of the United States have been so accustomed to lavish expenditures that they have expected and demanded the railroads to erect costly terminals and stations. Mr. Gordon's arguments are not directed against the railroads for their acquiescence in these demands, but against the communities in making them who must directly or indirectly bear the charges. Against the luxurious non-revenue producing structures he cites examples of others, sufficiently imposing for the most exacting, that can and do carry their own investment charges.—THE EDITORS.

MR. CHARLES EVANS, chief commissioner of the state railways of Queensland, Australia, said recently at the Chicago Engineers' Club, speaking of American railways: "They go in too much for gilded stairs and marble halls." The *Railway Age Gazette* in commenting on this, which was, of course, a hit at our passenger stations and passenger trains, remarked: "The railways of the United States have gone mad on the subject of providing enormous marble passenger stations, with immense amounts of waste space in them, observation cars, buffet, smoking cars, valets, maids, barbers and barber-shops, and stenographers, unnecessarily duplicated passenger train service, and scores of other luxuries, which cost money and which are unknown on the railways of any other country. . . . The gilded stairs and marble halls business is being carried too far all over the country."

Again, from the *Evening Post*, New York, September 24, 1914: "The announcement that Chicago has at last completed arrangements for a new union station to cost $65,000,000 and to be ready within five years is of national interest. . . . It must not be thought that the new station is 'union' in the large way that has sometimes been the dream of city planners in Chicago. The edifice will accommodate but a few of the railways that enter the city."

The railways of the United States have expended for new passenger stations during the last six years a total of more than two hundred and fifty million dollars, and have in contem-

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plation an outlay of seventy-five millions more within a short time. In view of the fact that the public is just beginning to understand the real plight of the railways and the difficulties that now beset their operation, can the extravagance shown in these magnificent terminals be justified as a wise policy for the future?

The traveling public have become accustomed to expect magnificent terminal stations in all large and in many small cities. Formerly, the average terminal on American railways, called the dêpot, was, in comparison with buildings of the same kind in Great Britain and continental Europe, badly arranged, often too small to accommodate the traffic, and usually ill-cared for and dirty. With an awakened public spirit and ever increasing demands by travelers for better facilities, the railways, a few years ago, embarked on a policy of lavish expenditures, went to the other extreme, and built mammoth stations that are, it must be said, the most beautiful structures of the kind in the world.

Has it not been overdone? Do the people at large realize the amount of money spent by the railways to provide these improvements? Do they appreciate to any marked extent the architectural features; and do they ever stop to consider their carrying charges? These considerations do not apply to the way stations, with the replacement and improvement of which there is little fault to find; for the average way station on American railways usually has been found to be ugly, poorly lighted, and dirty, yet a place where one must often wait for long periods of time; and any needed improvement in the appearance and size of the building, or in the manner in which it is kept, is a distinct advantage to the public and, within reasonable limits, a proper expenditure for the railway to make.

In New York City, the terminals of the Pennsylvania, finished in 1910, cost, with electric installation, and the approach tunnels under two great navigable rivers, about $115,000,000. The Grand Central Terminal of the New York Central, in the same city, cost somewhat more than $40,000,000 for the station and yard alone. The beautiful station at Washington, D. C., that forms one of the architectural features of the capital, required an outlay of $10,000,000; the Northwestern station in Chicago, opened a few years ago, $24,000,000, including incidental improvements; and the imposing Kansas City terminal, put in use in October, 1914, about $45,000,000, of which $6,000,000 represented the cost of the station alone. The projected west-side passenger terminal in Chicago, for the joint use of the Pennsylvania, Burlington, and St. Paul roads will cost, it is estimated, more than $65,000,000. These large sums of money have been put into real improvements, the enlargement or rearrangement of terminals, tracks, etc., and the construction of larger buildings, affording concourses and waiting rooms of enormous capacity, and furnishing every convenience that might be required by a traveler; all combining to produce the largest and most artistic, as well as the costliest stations in the world.

From the point of view of accommodations for the public, however, there is no necessity for the expenditure of so much money for passenger facilities. Many instances could be cited of stations in Great Britain and continental Europe, having as great a traffic density as that at the places just noted in the United States, wherein the first consideration was to furnish ample space for incoming and outgoing passengers and convenient means for enabling

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INTERIOR VIEWS OF THE PENNSYLVANIA STATION IN NEW YORK

Architecturally this station is a thing of beauty, but from the standpoint of convenience it is not an unqualified success. Passengers must traverse long corridors and descend long stairways to reach the train platforms. The only attempt to utilize the huge structure commercially is shown by the small shops along the corridors in the upper picture

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the former to reach the street and for the latter to gain access to the trains; at the same time providing all necessary conveniences and facilities. These buildings usually are not beautiful. Many of them are not imposing. It is easy to see that they are designed solely for station purposes, and, in most cases, they are large enough to accommodate the traffic.

BIRD'S-EYE VIEW OF PENNSYLVANIA STATION AND POST OFFICE, NEW YORK CITY

The station proper in the foreground covers two highly valuable city blocks, and is utilized only for travelers and the railway offices. The structure could have been carried up higher and used for hotel, office, or manufacturing purposes

Their cost has been only a fraction of the amount spent for similar purposes in the United States. These station buildings, however, would hardly satisfy the American traveling public. It is a national trait with us to be dissatisfied with that which fulfils its purpose without ostentation.

It must be borne in mind that railway operating conditions in foreign countries do not present the same problems as prevail here. American railway managers when planning new stations must look to the inevitable, rapid growth of communities and the traffic resulting therefrom; whereas in Europe, population is more nearly stationary and less provision need be made for future growth. The American road must furnish facilities ample for the ensuing ten or fifteen years. The structures, therefore, must be built of large capacity, but have we not treated the matter of size and ornamentation as the end rather than as the means of accomplishing our purpose? And have we not overdone the ornamental, the artistic side of our work, and as a result built stations that are not appreciated by more than a small portion of the crowd that uses them?

It is obvious that a railway, in improving or rebuilding a passenger terminal station must look well into the future, not only providing for

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GRAND CENTRAL TERMINAL, NEW YORK

The value of this property is evidenced by the high hotel and office buildings surrounding it. Although the station itself is non-revenue producing, yet the income from terminal developments in course of construction will amply carry the charges on the whole investment

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probable growth of traffic, but designing the station so as to furnish at once every reasonable facility for through travelers and the quickest means of access to and egress from suburban trains as well. Granted that these things involve a large expenditure of capital, is it not the duty of every board of directors to plan their great terminals so as to make them, to the fullest extent, revenue producers by combining the station proper with such a form of business building as is required by the surrounding neigh-

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MAIN CONCOURSE OF THE GRAND CENTRAL TERMINAL, NEW YORK CITY
After a long and fatiguing journey, few people have either the time or inclination to stop and contemplate the beauties of such a station

borhood, designing the building with an eye to good architectural effect, but avoiding entirely the construction of magnificent stations embodying decorative features which cost so much and from which there can be no direct return. Possibly this may be brought about to a degree by an education of the public taste. The people at large have been brought to expect the magnificent features of a railway station as a matter of course. If they can be shown that ultimately, if the railroads are to exist under private corporate management, every dollar of outlay must earn its quota of interest just as it must in any manufacturing or commercial undertaking, they may be led to take a more reasonable view of the matter and find their satisfaction not in admiration of the size and beauty of such terminals, but in the convenient arrangement of all waiting rooms, concourses, train platforms, and the means of access thereto, as well as in the scrupulous cleanliness which should prevail in every portion of such buildings and the maintenance of an efficient body of employees.

The people, in buying transportation, will not, knowingly, pay for architectural monuments, nor artistic ceilings, nor vast areas in which they may congregate to look at beautiful frescoes and well chosen inscriptions. It is not the function of a railway to provide these embellishments of a station either for æsthetic effect nor for the education of the people at large. They are incidentals in producing a pleasing result, but it must be remembered that ultimately, some portion of the community must pay for all such things, if not in the form of higher fares, then by means of added taxation brought about by government ownership.

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UNION STATION AT WASHINGTON, D. C.
A terminal structure worthy of the importance and beauty of the capital city

The public, constantly demanding better facilities, is in almost every case encouraged by city authorities and state commissions in requirements concerning the construction and arrangement of a terminal station. It is sometimes asserted that a spacious and beautiful structure attracts travel to the road possessing it. People admire it, feeling that it costs them nothing and that it furnishes a topic of interest for a time; but how many persons when planning a trip choose a certain line because it has a particularly beautiful station; and how many travelers arriving at such a station after a long and fatiguing journey, have either time or inclination to stop and contemplate its beauties? The rates charged for transportation may not be increased by more than a small amount, and the argument in favor of raising them should not take into consideration the extra cost and carrying charges for mammoth, ornate stations *per se*. Granted that an imposing railway terminal is an ornament to the city wherein it is located. The inhabitants point with pride to their newest building, and take delight in explaining its superiority over those at other places; but does anyone doubt what the reply would be if a proposition were presented to the taxpayers of the average American city to bond the municipality for at least a part of the cost of the new terminals sometimes so loudly demanded? This method of sharing the expense of an improvement jointly by a railway and the public is the same as that for the cost of separating street and railway grade-crossings. Possibly in time the public could be educated to the point where they would see the benefits arising from it, but at present they do not look with favor upon this plan of coöperation.

The Pennsylvania station in New York with the tunnels leading to it under the Hudson and East rivers was decided upon after it had been shown that the importance of a terminal in the heart of New York City for a vast system like the Pennsylvania was too great to be disregarded, considering also the probable growth of traffic, and the improvements that were started at about the same time at the Grand Central Terminal by the New York Central. The design of the Pennsylvania station aims to combine spaciousness, beauty, and general artistic effect with its usefulness as a terminal. In the opinion of many authorities, however, its convenience to the traveling public has not been an unqualified success. Certain defects of arrange-

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MICHIGAN CENTRAL STATION AT DETROIT

A beautiful terminal combined with a 15-story office building, the rents from which will pay the carrying charges of the whole development

ment for access to the train platforms and the means of reaching the concourse might even now be modified. The most noticeable thing about this great work is, when considering it as a whole, the enormous amount of space that has not been utilized. It is easy to conceive what could have been accomplished by carrying the structure up to a considerable height, providing thereby a building capable of producing large rental revenues, and withal a pleasing architectural effect. The upper stories could be used for hotel, office, or manufacturing purposes, and the investment would then justify itself on any and all grounds.

The Pennsylvania controls the Long Island railroad, and from the inception of this project, the accommodation of the trains of the latter was made an integral part of the plans. In addition to this, the Pennsylvania found an excellent opportunity to lay out a large storage and car-cleaning yard near Long Island City, using it for all its through trains which are taken through the East River tunnels to this yard for cleaning and making up. When needed, the empty trains are hauled back through the tunnel to the terminal at Seventh Avenue and 32nd street, New York, and placed at their proper departure platforms. From the operating standpoint this terminal is a success, but as a financial undertaking it cannot be so considered.

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HUDSON TERMINAL STATION, NEW YORK CITY

Another notable exception to the list of extravagant stations. Every available foot of space in the station proper has been rented for concessions, and the entire space above ground is occupied as a vast office building in the heart of the business section

At Grand Central, traffic conditions are different from those prevailing at the other great trunk line outlet in New York. In addition to the through and suburban trains of the New York Central lines, provided for on two separate levels, those of the New York, New Haven and Hartford are also accommodated. The New Haven road pays as rental for trackage rights and electric power over the twelve miles of line between the end of its own rails at Williams Bridge and Grand Central about $3,000,000 per year. Incidentally, comparing this sum with the total number of passengers using New Haven trains, the cost to that road for each passenger using the terminal is about thirty cents. However, that matter is concerned with another chapter of railway history.

The improvement at Grand Central is interesting not only on account of its great size but also because the scheme now working out has comprised placing all the tracks underground for a distance of one-half mile, the restoration of Park Avenue to the city from 42nd to 56th streets, and the improvement of the adjacent property by the construction of large buildings for hotel, club, and business purposes. In the 1913 report of the New York Central and Hudson River Railroad Company, the cost of the terminal improvement was carried as an item of permanent invest-

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ROCHESTER STATION, NEW YORK CENTRAL LINES
Just such elaborate stations have been built at Minneapolis, St. Paul, Spokane, and other cities

ment at $40,690,000. This sum was expended in the construction of the terminal station with its two levels of tracks, its connection with the subways, as well as in the excavation of Park Avenue and its subsequent roofing over in order to restore the street surface where formerly an open cut had existed. When the contemplated improvements are finished, it is estimated that the rentals from the various buildings surrounding the station and owned by the railroad company will amply cover the carrying charges of the investment. It must be borne in mind that the development of the city and its rapid transit systems have made the neighborhood of the Grand Central Station one of the busiest traffic centers in the world, and is making it more so every year, with the accompanying enhancement of real estate values; property within a reasonable distance of this point being worth between $2,000,000 and $3,000,000 per block. Thus it is evident that these two great termini differ, when considered from a financial standpoint; the Pennsylvania aiming to justify its existence solely on the ground of the necessity of a New York City terminal for the road, while at the Grand Central it is expected that the real estate investment will soon begin to earn its fixed charges.

The same cannot be said of the other vast terminal stations that have been erected recently. In Washington, D. C., the Pennsylvania, and the Baltimore and Ohio combined to construct a union station. These two roads had been using separate terminals, one of which had been outgrown and the other obsolete for some time. Public necessity, backed by the authorities of the District of Columbia, demanded a terminal structure worthy the importance and beauty of the capital city. The design might have been modified so as to include a large rentable space without seriously interfering with its beauty. Aside from being a station, however, it is merely a ten-million dollar monument.

The new Northwestern station in Chicago, replacing small and obsolete structures was of course needed, but here, as in Washington, no attempt

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GRAND CENTRAL STATION AT MEMPHIS, TENN.
The five upper stories provide 35,000 feet of rentable office space

has been made to utilize any part of the site for more than the purposes of a beautiful terminal. The yards, approaches, and incidental improvements in connection with this $7,300,000-structure cost about $16,000,000. Again, at Kansas City, the new $6,000,000 terminal has involved the rearrangement of yards and other necessary terminal structures at an additional cost of $40,000,000, one incidental item of expense being the construction of a sewer 25 feet in diameter and more than one mile in length.

One of the recent stations, that of the Michigan Central at Detroit, Michigan, is an exception to the instances noted above, the railroad company having built a beautiful terminal there at a cost of $2,500,000, combined with a fifteen-story office building, 345 feet long and 54 feet wide, with a wing at each end 108 feet wide. The rentals from this will go a long way towards paying the carrying charges of the entire undertaking, representing an investment of $7,000,000. Another notable exception to the list of extravagant stations is the Hudson Terminal in New York City. The underground terminus provided for the tube trains from Newark, Hoboken, and Jersey City, is excellently suited to accommodate the traffic of these lines for some time to come. The design is strictly utilitarian, as no attempt to beautify this terminal was made. Every available foot of space the

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UNION STATION AT WICHITA, KANSAS

spared has been rented for concessions such as newsstands, soda fountains, and shops of various kinds. The entire space above ground, for two blocks on Church street, from Cortlandt to Fulton, is, as almost everyone knows, occupied as one vast office building. Architecturally, the style is plain but well suited to the surroundings.

Elaborate passenger terminals have been built not only at the large eastern cities but at other points throughout the United States as well. At Rochester, N. Y., the New York Central has recently completed a station costing almost $700,000. Minneapolis, Minn., has decided to erect a municipal union passenger terminal and to oblige all railways entering the city to use it, in spite of the fact that the Great Northern had opened a new station in that city about a year ago at an expenditure for building and approaches alone of $1,300,000. At St. Paul, Minn., plans have been completed for a union terminal that will cost, including approaches and necessary changes, grading, etc., more than $15,000,000. Again at Spokane, Wash., the Oregon-Washington Railroad and Navigation Co. has under construction a passenger and freight terminal that will need $3,000,000 to complete, in addition to the $4,000,000 which has been spent for right of way to give access to these terminals. A large part of the former sum is to be spent on the passenger station alone.

A union passenger station to be used by nine railroads entering the City of Dallas, Texas, will soon be finished. The cost of this improvement including the approaches will be about $2,000,000. It will take the place of five separate stations now used by the railways concerned, but it has been necessary to expend $1,750,000 for land in addition to the sum above mentioned in order to carry out the plan. In Memphis, Tenn., the Illinois Central has just finished a passenger station costing more than $1,400,000. The railroad occupies only a part of this building, however, which has 35,000 square

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WINDSOR STREET STATION AT MONTREAL, CANADIAN PACIFIC RAILWAY

feet of rentable office space in its five upper stories. An undertaking such as this is justifiable for a railway company, and the city where it is located is benefited as well. At Wichita, Kansas, the Rock Island, the "Frisco," and the Kansas City, Mexico and Orient roads are completing a union station, which, with the incidental improvements, relocation and elevation of the tracks, etc., will involve the expenditure of more than $2,000,000.

While the replacement of a passenger station often requires radical changes and rearrangement of yard tracks and signal installation, it is unnecessary, merely for the accommodation of travelers, to provide structures of magnificent design and ornate finish. The attempt made by the smaller and less important cities to copy the structures of the few great termini on a similar scale is a costly mistake.

There is no good reason, economic or otherwise, for making terminals any larger or more ornate; they are big enough, for greater size involves greater complexity; and there are strong reasons for adapting them more particularly to the needs of the various kinds of traffic, of practicing much greater economy in their design and decoration, and in utilizing the upper portions, even to the extent of increasing their height many stories, for use in business or hotel undertakings. This last is not to be ignored, even in the United States.

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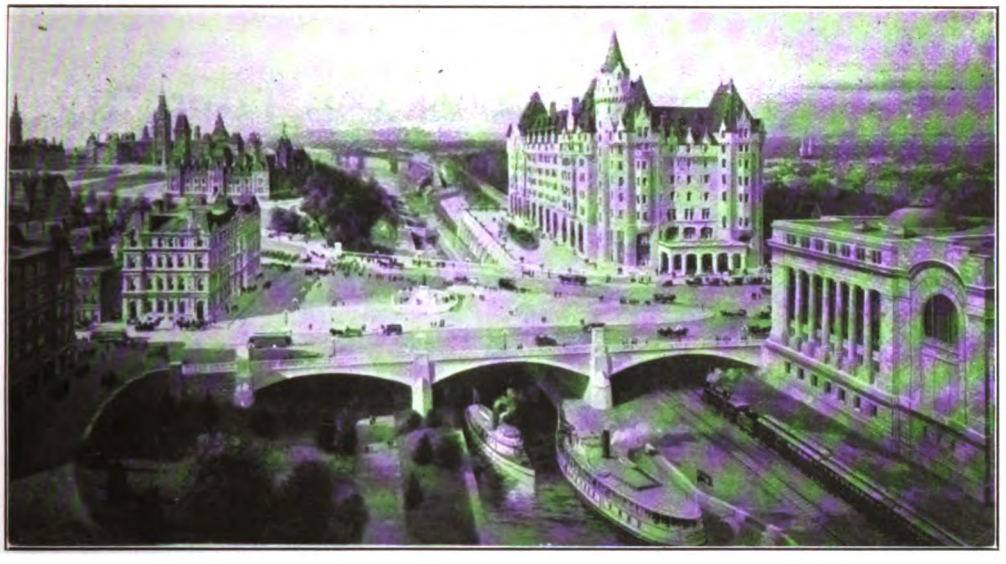

NEW TERMINAL OF THE GRAND TRUNK RAILWAY AT OTTAWA

View showing the Canadian Houses of Parliament on the left and the Chateau Laurier and the railway station on the right. The lower story of the hotel has entrances to the station and to the city trolley lines

The station hotels of Great Britain and Europe have long been fixtures filling a recognized public need. In Canada, the Canadian Pacific and Grand Trunk railways have many such hotels and continue to build them, not only in the western provinces but at Ottawa and Montreal. It does not seem unreasonable to expect that in the United States the public could be induced to use such hotels to a profitable extent, in which case one of the problems of the great terminal stations would be solved.

Without considering the replacement of existing structures when they have been outgrown by the traffic, the erection of new terminals will have to be planned with a view not only to the satisfactory accommodation of travelers, but also with a design that will restrict the cost to such limits that the interest charges on the improvement may be easily met. The railways being public carriers under government control, are obliged to furnish all reasonable conveniences in the form of stations; but beyond this requirement it is unlikely that any more great buildings of the kind forming the subject of this article will be constructed. The railways at present are unable to secure sufficient capital to take care of the most pressing kind of improvements, and beautiful buildings certainly do not come under this designation. If government ownership should ever come about in this country, perhaps it would be deemed expedient to erect magnificent terminals for the sake of their artistic effect on the public. Under present conditions of almost stationary rates, increasing costs of labor and material, and legislative interference, however, no railroad corporation can afford such expenditures. Mere architectural effects must be subordinated to utilitarian considerations. Magnificent passenger stations are not essential for public convenience; the sooner the people decide they can do without them, the sooner will the railways be relieved of a burden of extravagance.

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WATER POWER LAWS AND THEIR RELATION TO INDUSTRY AND PROGRESS

By F. Darlington

The present Congress will be called upon to modify the Federal Reserve act so that available water-power resources may be utilized under lease to the benefit of the public. It is probable that the State or the Government will be empowered to revoke any lease that is wrongfully managed to prevent abuse. Mr. Darlington, who has made a profound study of the subject, believes that such a policy will open up a vast territory to the development of hydro-electric service that will result in cheap power and, therefore, in an increase in manufacturing enterprise.—THE EDITORS.

IN the early days of the settlement of the United States, before the time of railroads and of power transmission, rural communities depended upon small grist mills for grinding their grain and these mills depended upon water for their driving power. To assure that water powers would be available, laws were enacted giving the right to condemn lands for dam and mill sites, so that the owners of water powers could, if necessity arose, be compelled to permit their use for grist mills. In recent years an important action in a water power case in the state of Virginia was based upon such a law.

The same principles should govern the enactment of present-day laws; for water powers are still essential to maximum prosperity and must be made available for the communities in which they are situated. The Congress now in session will be called upon to pass laws governing the development and control of water powers that are located on Federal reserve lands, or on navigable streams, or that are for other reasons under Federal jurisdiction.

It is the purpose of this article to consider the relation of water powers to prosperity and progress, and to show how far reaching will be the benefits from their use to the communities directly affected and to the whole country, and how widely diversified are the industries that will profit directly or indirectly by their development.

To appreciate the full measure of opportunity and reward that will follow the extended use of water power, certain fundamental conditions, which are the basis of the economy and profit of water powers, must be understood. The terms "economy" and "profit" are here used in their broadest sense to express the saving in resources and human endeavor by doing useful work by the most efficient means, thereby producing a nation-wide benefit. The profit to be earnestly sought from water powers is not the return that will accrue to the managers and capitalists who will devote their time, skill, and money to making the developments and distributing the power. Public service corporations with vast amounts of capital are, in all probability, the means by which the work will be done; but the ultimate profit will be the advantages gained by the many branches of industry and commerce, for these will benefit the entire nation, just as truly as the early settlers were benefited by the use of water-power re-

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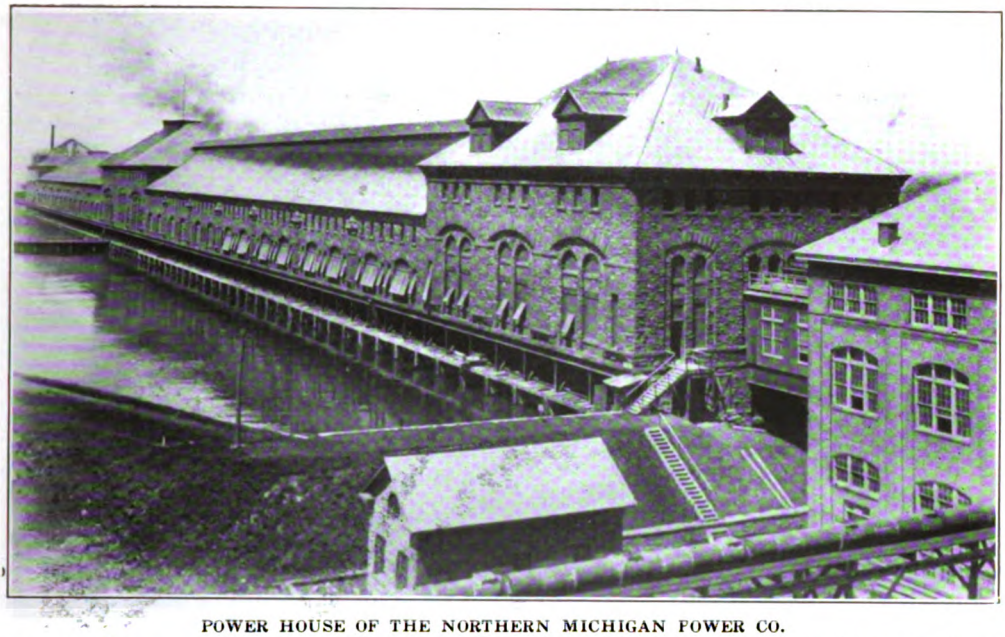

POWER HOUSE OF THE NORTHERN MICHIGAN POWER CO.

sources for grinding their grain.

Conditions are widely changed since the days when the main and indeed, except in manufacturing districts, the only use for power was to operate grist mills. Power in the form of electric energy is now widely distributed throughout every community and supplied in innumerable subdivisions for manifold uses. The needs and convenience of every-day life demand it for dozens of applications, and every one has become so accustomed to its benefits that we hardly realize how universal it is.

Already so-called unified electric systems cover large areas in nearly every state in the country. Even a brief schedule of these systems would require more space than is available in this article. But these are only a nucleus for the unified systems that are in process of development. Take, for example, the New England and Middle States. It is only a matter of a relatively short time before electric power lines with frequent lateral branches will extend continuously from Boston to New York, from New York to Albany and thence to Niagara Falls, from New York to Philadelphia and thence to Baltimore, Washington, and Richmond; from Philadelphia to Pittsburgh and thence to Erie and Niagara Falls, and from Pittsburgh to West Virginia and to points in Ohio and even further west. These great interconnected arteries for electric energy will be fed from numerous generating plants, and every demand for power within reach of their lines will be supplied from the vast unified system. An important function of these big systems will be to furnish energy for railroad electrification. This accomplishment will be greatly advanced when electric power can be supplied to trolleys and third rails from power distribution lines which will furnish power alike for all applications, whether for railroads, for mills, for lighting, or for private purposes. In this way the railroads will be relieved from going into the power generation business, and at the same time

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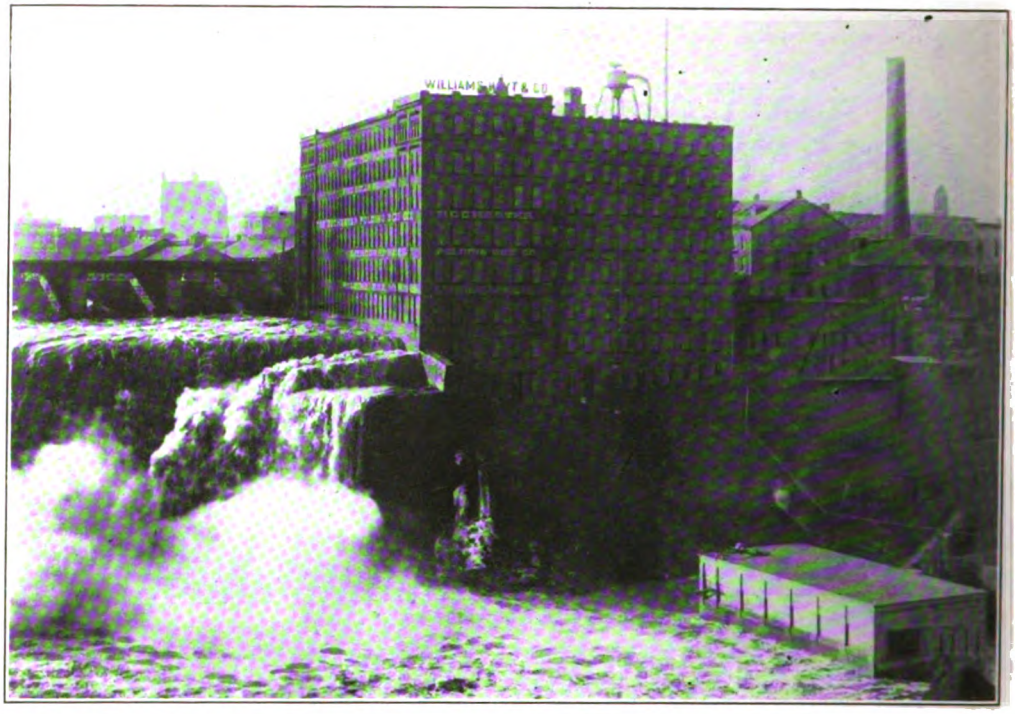

ROCHESTER ELECTRIC LIGHT & POWER COMPANY POWER HOUSE AT THE EXTREME RIGHT

they will secure their power from larger and more economical generating plants and distribution systems than they themselves could afford to construct for their own uses only.

The part that water powers will play in the future power business of our country will depend upon their relative economy as compared with steam power in supplying electric energy to these enormous power distributors; for, except in isolated and exceptional locations, the future use of water powers will be for feeders to the big systems, with little regard to their utility for small factory or public utility work.

Fortunately, however, for the further development of hydro-electric power and the consequent conservation of this natural resource, the most efficient use of water powers is in connection with just such great systems.

The following table of the annual sale of electric power per capita in several large cities shows the importance of central-station business. The table is taken from an address by Mr. Samuel Insull before the Finance Forum in 1914:

ANNUAL INCOME FROM SALE OF ELECTRICITY

	Per Capita
Baltimore	$4.22
Philadelphia	4.65
New York & Brooklyn	6.37
San Francisco and vicinity	6.40
Boston (city and suburbs)	6.48
Chicago	7.18

Electric power business is not confined to large cities, however, and if statistics were available it would be seen to be country-wide. The problem herein considered is how best to generate and deliver power wherever it is required in small or large units, and to find what proper part water powers will play in its generation.

In view of the low cost and high

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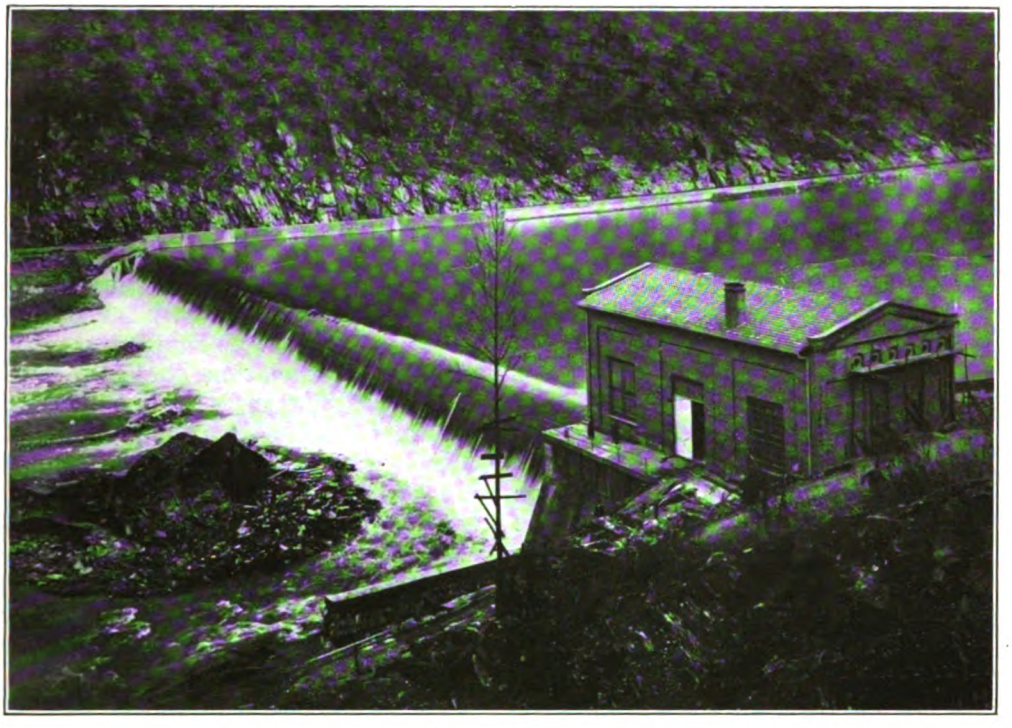

POWER HOUSE OF THE NORTH CAROLINA POWER CO.

economy of steam turbine plants, many people are of the opinion that, except in rare instances, the present-day cost of making power by steam is less than by water power if first cost and depreciation are taken into consideration. They point out that the development of water powers rarely costs less than $60 and often over $100 per horsepower, as against $35 to $45 per horsepower for big steam turbine plants.

There is an opposite opinion held by many that since water costs nothing and coal is costly and continually increasing in price it must be less expensive to make power by water than by steam, wherever the conditions are reasonably favorable for water power.

The truth is that both opinions are right and both are wrong, the explanation being that the relative economy largely depends on the number of hours per day or per year that the power is furnished.

Some exceptional industries, like certain electro-chemical works, require practically continuous power 24 hours per day and 365 days per year. Under favorable conditions, water powers having a continuous supply of water are vastly superior to steam for such work, since the coal consumption to keep a steam plant working continuously full loaded would be very great, far greater in fact than the fixed charges and depreciation on the first cost of a hydro-electric plant.

Other and far more numerous uses of power do not require service continuously, but only for a portion of each day. These uses include all public service power work, embracing electric lighting and power for driving shops and mills and for domestic purposes.

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The consumption of coal for part time operation is not nearly so great as for continuous working, and the lesser first cost of steam plants as compared with hydro-electric plants often more than offsets the expense for coal. Under such conditions, steam is cheaper than water.

In public service business, where a large number of customers are served from one electric distribution system, the average of their combined requirements produces a load that is much less during the late night and early morning hours than in the day time, and that is much heavier in the late afternoons and early evenings than at other times. This variable demand is characteristic of public service work and can often be most advantageously supplied by using two sources of power. If one of these sources gives superior economy when working continuously, then the other source need be used only during the hours of extra heavy or so-called "peak" loads when the total load on the system exceeds the capacity of the first source. In this way, water power and steam power may jointly supply a single system, each source being worked under conditions in which it gives superior economy. Since water costs nothing, economy dictates that in such cases the water-power share of the common load should be the largest it can produce, with steam generation only for the excess above the capacity of the water power. The advent of great electric distribution systems has enhanced the value of water powers for use in this manner and has made their further development a matter of prime economic importance.

Appreciation of the importance of water powers as a means of increasing national wealth and prosperity will follow clearly upon an understanding of the economic conditions underlying power manufacture and distribution.

The cost of power may be divided into two different and wholly distinct elements: The first is fixed by the investment in the generating plant, and the force of men and the organization that must be kept on hand to operate it. It is a constant expense whether the machinery is generating power continually or only for a short time each day. It includes the interest and depreciation charges, taxes and insurance, the wages of the attendants on duty to operate the machinery, and all those expenses that are not affected by the actual delivery of power by the machinery. This fixed or readiness-to-serve expense is practically unaffected by the hours of use of the plant, being substantially the same whether it is used one hour or twenty-four hours every day.

The second element in the cost of power is the expense to provide the materials that are consumed by operation, such as oil and supplies, and the parts that wear out by use, and, in the case of steam plants, the coal that is burned. This second element of cost varies with the hours of operation, and the sum of the two—the fixed and the variable—make up the total cost of power.

Another condition encountered in generating power may be stated in a few words, namely, the cost of production diminishes rapidly as the size of the generating plant is increased. This does not require demonstration, except to indicate the extraordinary range in cost because of differences in size of generating plants. The reduction with increased size holds good both in the capital cost per unit of installed plant capacity and in the operation and maintenance per unit of energy produced, and is more marked in steam than in water-power plants, since the size of the latter is

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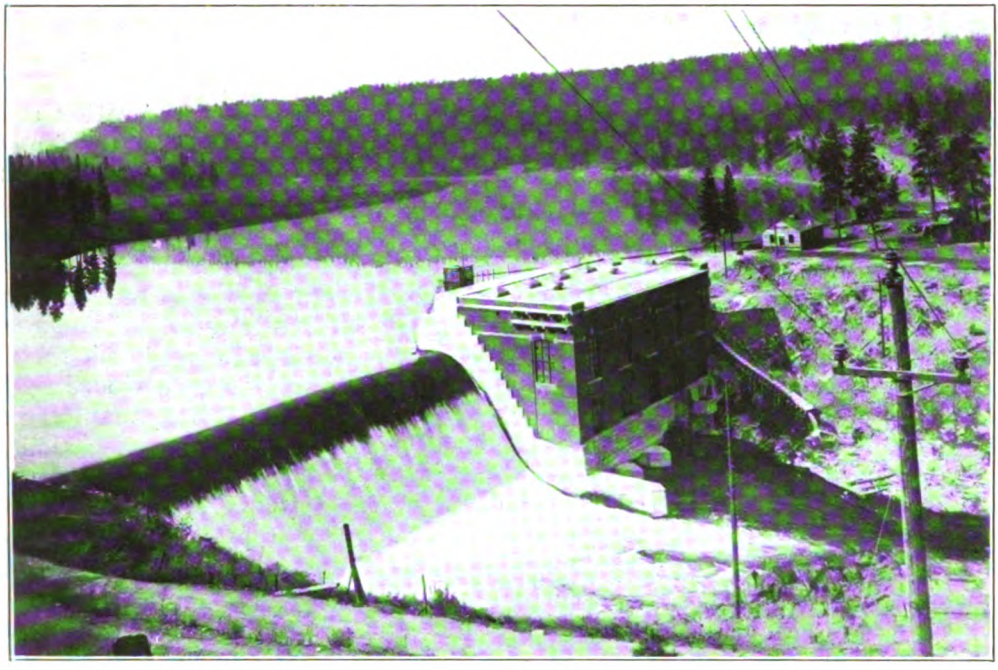

NINE MILE PLANT OF THE SPOKANE & INLAND EMPIRE RAILWAY
126 miles of the Inland Division is operated from this generating station

usually limited by the water power available.

That the construction cost per unit of capacity and the operating expense per unit of power generated in large plants is less than in small plants is an important source of economy and profit to the large central power systems so rapidly developing throughout the country. These mammoth systems, with favorably centralized steam or water generating plants, can secure connected loads over large areas that are the sum of numerous smaller individual loads. By superior economy in production in large units they are enabled to pay all the cost of generation and distribution, and they can still sell power at favorable rates, as compared with the cost of manufacturing it in smaller blocks, notwithstanding that their distribution systems usually cost at least as much and often much more than the generating plants to which they connect.

Striking examples of this may be seen in central power companies serving electrical power to coal companies for mining coal. In places where a number of mines are located in a district in which the transmission distances are not too great, central-station companies build up a profitable business in generating power by either steam or water and selling it at the coal mines in blocks ranging from less than 50 horsepower to 500 horsepower and upwards, their transmission lines in some cases extending more than 50 miles from their generating plants.

Still another fundamental principle in the central-station power business is that it is more economical to serve a number of different customers with diversified interests from one generating source, than for each interest to make its own power. This economy arises from better utilization of the central power plant and in-

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creased average use of the installed machinery, since, wherever a large number of power users are served from a single system, the individual maximum loads of all the different users never occur simultaneously. It is quite common for the maximum load on a central-power system to be only one-half or three-quarters as great as the sum of the maximum power requirements of the various customers, simply because the maximum loads of the individual customers do not all occur at the same time. Though the result of this is that the maximum demand on the central-station plant is not as great as the sum of the customers' maximum, yet the average use of the central power-plant machinery is largely increased by the steady and continuous load resulting from the combination of a large number of individual, though variable, demands for power. Power companies have so effectively combined the loads of their various customers that the loads on their systems generally average between 30 per cent and 50 per cent of their maximum output, although the average load of each individual customer is seldom as much as 30 per cent of his maximum load.

Briefly summarized, the cost of power generation is reduced:

(*a*) By using large generating plants, thereby securing the greatest economy in construction and operation;

(*b*) By loading the power plants as continuously as possible, thereby getting maximum use of the machinery.

The original purpose of many electric systems was to distribute cheap hydro-electric power, but today nearly all of them, especially the larger ones, use both water and steam as a source of power and the future of hydro-electric development depends upon the relative economy of water and steam as a means of generating electric energy for feeding into these great systems.

The cost of power generation and distribution varies so greatly under different conditions that no direct comparison is possible between the cost of steam power and the cost of water power, but the correct answer for any specific case may be found by analysis of the fixed and variable elements of cost as already set forth. In nearly every instance where both water and steam are available, the answer will be that the best economy is gained by using them in combination. The cost varies in different locations and under different conditions, according to the size of generating plants, the cost of fuel and the water powers available. The cost for water power will also depend upon whether there are ponds in which water can be stored and held from rainy seasons to dry seasons; whether, lacking large storage ponds, they must use the natural flow of the rivers which afford abundant power when the rivers are high, but are short of power when the rivers are low, etc.; or whether, in exceptional cases like the Niagara Falls powers, water may be abundant at all seasons, sufficient for the full capacity of the installed machinery.

The construction cost of a hydro-electric plant is usually much greater than for a steam-turbine plant of equal capacity. It is rarely less than $75 per horsepower and is often more nearly $150 per horsepower. This makes the constant or fixed yearly expense covering interest and other fixed charges greater for water than for steam plants, but, on the other hand, the force of men required for the operation and maintenance of a hydro-electric plant is less than for an equivalent steam plant, and the water may be said to cost nothing as

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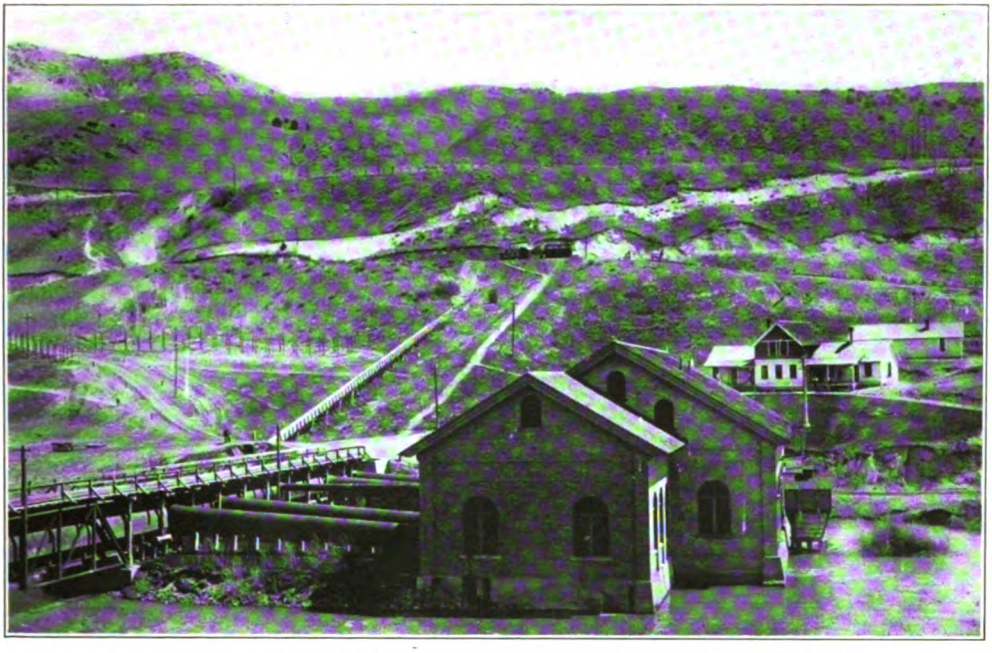

POWER HOUSE OF THE UTAH-IDAHO SUGAR CO., WHEELTON, UTAH

against the expense of coal for steam.

Though the cost of water-power plants varies between wide limits, an approximate average figure of $100 per horsepower may be assumed to give some concrete basis to this discussion, and, provided the plant is a large one, an annual expense of $1.50 per horsepower per year may be assumed to cover the labor and materials for operation and maintenance. On these assumptions, the annual cost per horsepower per year of power by water would be:

For interest, taxes, depreciation, etc., at, say, 10 per cent.	$10.00
For labor, and material for operation and maintenance.	1.50
Total per year	$11.50

This annual cost is very little affected by the hours per year during which the machinery is operated, since, unlike steam power, it requires no expenditure for coal, and the oil and other materials and the wear of the machinery are covered by the above allowance of $1.50 per horsepower per year for labor and material. Consequently, the cost per horsepower of water power is practically fixed by the investment in the plant, with a small addition for operation and maintenance, the total of which in the assumed case is $11.50 per year.

Unlike steam plants, the amount of energy that can be produced in a year by water power plants is not determined by the size of the plants, that is, by the capacity in horsepower of the installed machinery, but it depends on the amount of available water that can be used to operate the machinery during those times when power is demanded. The most favorable condition, which is extremely rare and of which some of the Niagara Falls powers are examples, is where there is always an abundance of water and always a use to which the power can be applied. In such cases, each horsepower of installed machinery can theoretically be used

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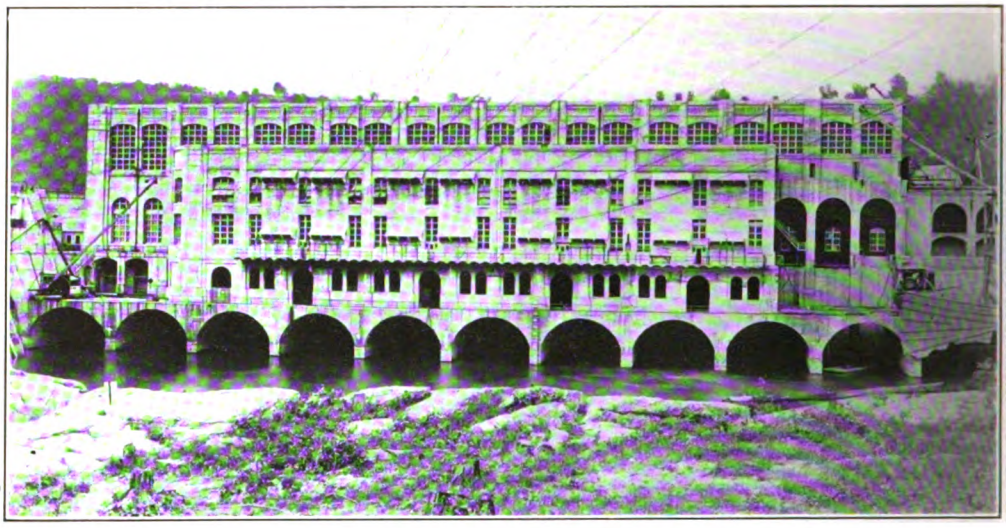

POWER HOUSE OF THE PENNSYLVANIA WATER & POWER COMPANY, HOLTWOOD, PA.

to generate a horsepower-hour of energy for each hour of each year—8,760-horsepower-hours per year; or, allowing a margin for shutdowns for repairs, etc., say 8,000-horsepower-hours per year. At a cost of $11.50 per horsepower per year, this makes the power cost 0.14 cents, about one-seventh of a cent per horsepower-hour.

On the other hand, if such a water power with continuously abundant water were the only source of power for a central-station system distributing power to diversified industries and public service uses, in which the average use of power was only 40 per cent of the maximum demand, then the water power could only furnish the system 40 per cent of the total energy it was capable of generating in a year; and if there was no other use for the remaining 60 per cent available, it would be wasted, and the power generated by the water power would be only 3,504 hours per year, the cost remaining $11.50 per horsepower per year, the horsepower-hour cost becoming 0.33 cents.

Another favorable condition is where surplus water can be impounded and held stored in natural lakes or artificial ponds to be drawn upon when and as required. Where natural conditions make this practical without too much expense, it is sometimes possible to use the entire flow of a river to meet the most variable demand for power by regulating the flow to the times that power is required. The Salmon River power in northern New York is an example of a water power with large storage capacity. Most water powers have artificial dams which create a reservoir of limited capacity, sufficient to equalize the flow of water from hour to hour throughout one day and usually to equalize the Sunday variations to the weekday demand, but it is uncommon to have storage sufficient to conserve the water from seasons of flood for use in long seasons of drought.

By far the most usual condition is in the so-called "flow of river powers." These are exemplified at Keokuk on the Mississippi River, at McCall's Ferry on the Susquehanna, at Lock 12 on the Coosa River, and at many other places. These rivers are subject to periods of extreme flood

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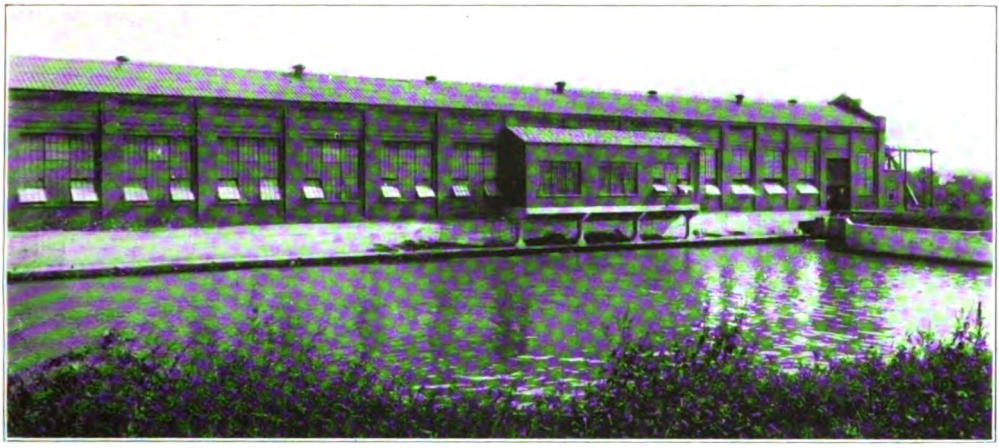

FOREBAY AND STATION OF THE DAVIS WATER-POWER PLANT, SEARS, ILLINOIS

with other periods of low water. The storage reservoirs created by the power-plant dams are wholly inadequate to retain flood waters for use in seasons of drought, although they are entirely sufficient to retain water during nights, when the demand on the power systems is relatively small, to be utilized during the daytime when the demand is large.

The capacity of the machinery installed in "flow of river" plants is never great enough to use all of the water during flood periods, but it is invariably far in excess of the minimum flow. The result is that there are days or weeks in each year when there is enough water to operate the machinery continuously at full capacity, and, at other times, there is only enough water to operate a small part of the plant continuously, or, by drawing upon the storage reservoir, to work the machinery fully loaded for a short time each day.

Such plants in particular have their best application in connection with large, central, power distributing systems, and can often be used at excellent profit in conjunction with steam plants to secure much greater economy than could be had with water or steam alone.

On nearly every power system, except in a few rare instances where the work is largely electro-chemical, the load after midnight and during the early morning hours is only from one-eighth to one-fourth of the maximum daytime load and it is generally greater in winter than in summer. There is a marked similarity in these daily and seasonal fluctuations among the large power distributing systems. This follows from similarity in the habits of the people served, and the uses they make of power the world over. Generally speaking, mills and factories take power mostly in the daytime, and small motors and heating appliances are used chiefly during the day. The use of energy for electric lighting commences at dark and reaches its maximum during the early evening hours and in the short winter days—though not in the long days of summer—the lighting load comes on before the power load goes off. Street cars and interurban and other railroad loads usually attain their maximums in the early morning and early evening hours. In cold countries, especially where there is snow, the railroads consume extra power in winter for car heating and snow-removal work. The net result

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is that the average use of power in extended communities, where electrochemical work is not important, is ordinarily only about 30 to 40 per cent of the maximum demand.

Extended distribution systems are especially advantageous for marketing power from two or more generating plants of different characteristics as to cost of production and hours of production, etc., to attain a resultant economy that could not be secured in any other way. Ordinarily the larger the systems supplied, the greater the advantage.

For example, assume that it is required to supply power for an electric distributing system that, for the heaviest day of the year, requires a power supply of 1,300,000 horsepower-hours at a maximum demand of 100,000 horsepower and a minimum of 20,000 horsepower. Also assume, what would be quite in accord with experience, that in no day of the year will the average requirement for power above 60,000 horsepower exceed 200,000 horsepower-hours—equivalent to 40,000 horsepower for five hours per day. If this system is supplied from a 60,000-horsepower hydraulic plant, with a steam plant auxiliary, the hydraulic plant could supply all of the power up to 60,000 horsepower during seasons of plentiful water, leaving only 40,000 horsepower during the peak load hours only to be supplied by the steam plant, which, working for only a short time daily, could supply this balance without great consumption of coal. On the other hand, if water became scarce for a few days or weeks at any season, the water-power plant would be used only during the daily maximum or peak loads, which are of short duration, and the flow of the river would be impounded during the balance of each day when the power demand came within the capacity of the smaller auxiliary steam plant.

In any case, this condition of continuous steam operation would be of short duration corresponding to the period of drought, with the net result that the available water would have been utilized to the fullest extent practicable and the steam plant used for the minimum hours of service.

Water powers provided with storage reservoirs, capable of retaining large volumes of water for use in seasons of drought, are an ideal supplement to flow of river developments to supply the shortage during dry periods, and for such work are operated in the manner just described, thus conserving their stored supply to furnish the long-hour service or so-called "base' part of the load when the "flow of river" plants are short of water.

According to an estimate of the United States Census, there is 37,000,000 horsepower available for water power in the United States that can be developed at a cost which compares favorably with steam, and only about one-tenth of this has been developed. Nearly all of the largest and best undeveloped powers are on so-called navigable streams, or on forest reserve or other Government lands, the use of which has been restricted by the "water-power" laws now on the statute books; laws that were enacted when our legislators were considering the early grist mill or isolated factory types of power.

The lands needed for water powers usually have little value for other purposes, and the duty of enacting new laws to open the way to turn the wasting water into wealth producing power is now before Congress. It is not a question of appropriation or of surrendering valuable resources to predatory trusts, but of enacting laws that will remove all unnecessary restrictions and encourage private or

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corporate capital in using hydro-electric power in the great transmission systems of the country. It is generally conceded that Congress should not surrender these imperishable natural resources for all time, but that grants for fifty years, or other reasonable periods, should be given wherever it will lead to the conversion of the wasting water into useful work. Granting these rights without any unavoidable restrictions should be the Government's contribution to the splendid wealth-producing industry of power generation and distribution by unified power systems operating on the broad lines along which this industry has already made good progress.

Fifty years' use of the water that is now going to waste is a small price to pay for the great benefits which will result when water powers are used on the large scale that will follow the enactment of favorable laws.

LOGICAL FACTORY COSTS

By W. E. McHenry

In our January issue the papers by Mr. Gantt and Mr. Ficker both called attention to the need for a decided revision in the method for determining manufacturing expense. In this paper, Mr. McHenry, who is a widely recognized cost expert, adds his voice to the disapproval of the older inaccurate method and to the adoption of an accurate distribution of costs.—THE EDITORS.

THIS paper is a plea for the exercise of common sense in a department of the factory which has been strangely neglected in this respect—the Cost Department.

Every business man carries a watch and consults it, both as to how much time has gone and whether time remains to do this or that—to keep an appointment or catch a train. Its greatest value is with respect to the future, rather than the past, and it is used constantly to plan ahead. Naturally, the prime quality sought in a watch is—reliability; and its owner is quite content to remain in ignorance of its works, if the results can be depended upon.

Why so many practical business men should reverse all this when it comes to the vital records of their business is hard to comprehend. Living in the present in every other matter, the alert manufacturer still regards his costs chiefly as records of what has happened—last year or last month. Sacrificing reliability to "simplicity of works," the manufacturer is too apt to pin his faith to any cost system he can understand, and justifies this faith by a reasoning which, applied to a watch, would be ludicrous: "I have entire confidence in my watch because I can see the works and the sum total of movements of the escapement, divided by 300, gives the *exact* number of minutes shown by the hands—my bookkeeper worked this out, and I have had a professor of mathematics verify the calculation. My watch is all right."

That we do not apply such silly arguments to a timepiece may be due to two circumstances; we have "standard" time by which to check the watch and we have means of "immediate" comparison. In the absence of these an ingenious watchmaker could produce two timepieces, one of which would run with perfect reliability and the other (being a "trick" watch) would put but 40 minutes in the first hour and 80 minutes in the next, and yet show precisely the same total each twenty-four hours.

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OLD METHOD OF TREATING "OVERHEAD." TABLE I

Month	Units of Product	Factory Expense		Expense per Unit	Overhead per Unit, including average Depreciation & Interest at 43 cents
January	3100	$2745.		0.89	1.32
February	2300	2371.		1.03	1.46
March	1700	2955.	(.40)*	1.74	2.17
April	2500	2722.		1.09	1.52
May	3400	2779.		0.82	1.25
June	4075	2830.		0.69	1.12
July	3800	3029.		0.80	1.23
August	3660	2912.		0.80	1.23
September	2210	2532.		1.15	1.58
October	3375	3628.	(.24)*	1.07	1.50
November	4430	3595.	(.14)*	0.81	1.24
December	3000	2330.		0.78	1.21
Total	37550	$34428.		$0.916	$1.346
Depreciation		5824.		0.155	
5% Interest on Investment — Plant, etc.		10344.		0.275	
Total Overhead		$50596.		$1.346	

* Excess Repairs.

Strangest of all, is the fact that perfectly honest accountants have produced "trick movements" in the cost department without being aware of it.

Too often the effort to create a simple method for a complicated problem has led to a "system" which indeed may be readily understood, but the results of which are obscure and misleading. On the other hand, some conscientious attempts to avoid obscurity in results have saddled the unhappy accountant with a system which, like the First Book of Chronicles, is perfectly clear but rather extended.

"What, then, is a good 'system'?" is asked.

As well ask a physician "What is a good medicine to take?"

The manufacturer who produces but one kind of soap, or one style of catsup, or one sort of glycerine cough tablet, has a comparatively simple proposition, his chief source of trouble will be the bearing of expense (the expense "burden") under varying conditions. As this question extends through the whole field of cost accounting, increasing in difficulty as the variety of products and number of operations increase, let us take a very simple case as an illustration.

I have in mind a manufacturer who produces an article selling for $10, his maximum capacity being 1000 per week, and the demand varying from as low as 200 per week to maximum. His bookkeeper had some coaching in cost work (see statement above) and the expenses of the factory had been kept under twelve or fifteen captions for several years.

Based on the data available it was possible to prorate the foregoing over the fifty-two weeks in a year and set up the following:

At a weekly output of.	20 per cent (200)	40 per cent (400)	60 per cent (600)	80 per cent (800)	100 per cent (1000)
The weekly overhead will be about	$800.00	$847.00	$945.00	$989.00	$1035.00

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The cost of material and direct labor (the latter being piece-rates) amounted to about $7 per unit; and, by the common method, we have:

At	20 per cent	40 per cent	60 per cent	Avg. Last Year	80 per cent	100 per cent
Unit cost of overhead.	$4.00	$2.12	$1.58	$1.35	$1.23	$1.04
Material and direct labor	7.00	7.00	7.00	7.00	7.00	7.00
Total cost of each....	11.00	9.12	8.58	8.35	8.23	8.04
Selling price	10.00	10.00	10.00	10.00	10.00	10.00
Profit—each	$0.00	$0.88	$1.42	$1.65	$1.77	$1.96
Loss— "	1.00					

What might such a course lead to? The average cost man follows the conservative rule of distributing what he terms "actual" expense, and his

While I think that any manufacturer, having the matter set before him as clearly as this, should be able

absurd attempt to make the separation of "unearned" expense would likely be this:

At	20 per cent	40 per cent	60 per cent	80 per cent	100 per cent
Weekly expense....	$800.00	$847.00	$945.00	$989.00	$1035.00
Proportion of expense to output..	$160.00	$338.00	$567.00	$791.00	$1035.00
Material and direct labor	1400.00	2800.00	4200.00	5600.00	7000.00
Total cost	$1560.00	$3138.00	$4767.00	$6391.00	$8035.00
Unit cost	7.80	7.85	7.95	7.99	8.04

to form correct conclusions as to his *SELLING* problem, this method of figuring has been justly criticised.

The argument is, that, at say twenty per cent output, eighty per cent of the capacity is idle or unutilized, and that the portion of overhead which belongs to this idle capacity is "unearned," as far as product is concerned, and should be kept separate from cost of items actually made.

Let us now try using standards. We found the prorated expense, running full, about $1035, and the output, about 1000. For practical purposes we adopt, as a standard rate for distributing the burden in this case, $1 (instead of $1.035) per unit.*

Arranged on this basis, the same "facts" will assume a different aspect:

At	20 per cent	40 per cent	60 per cent	80 per cent	100 per cent
Material and direct labor	$1400.00	$2800.00	$4200.00	$5600.00	$7000.00
Expense: by Standard rate	200.00	400.00	600.00	800.00	1000.00
Total cost	$1600.00	$3200.00	$4800.00	$6400.00	$8000.00
Unit cost "Standard".	8.00	8.00	8.00	8.00	8.00
"Unearned expense"	$600.00	$447.00	$345.00	$189.00	$35.00
Per unit	3.00	1.12	0.58	0.23	0.04

* In actual practice, a standard rate is seldom based on units of output, but upon time or service of equipment used; this gives an index of variation in output in a given time and the cost of such variations in efficiency of operation.

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STANDARD BURDEN RATE METHOD OF TREATING "OVERHEAD." TABLE II

Four Week Period	Units of Product	"Earned" Expense per Unit	STANDARD EXPENSE "Earned" Expense	"Unearned" Expense	Total "Standard" Expense	Actual Expense
1	2800	$1.07	$3000.	$ 905.	$3905.	$3914.
2	2300	1.04	2400.	1370.	3770.	3780.
3	1600	1.00	1600.	1845.	3445.	3439.
4	1950	1.03	2000.	1590.	3590.	3584.
5	2850	1.05	3000.	905.	3905.	3878. (?)
6	3200	1.06	3400.	595.	3995.	3927. (?)
7	3575	1.06	3800.	285.	4085.	4053. (?)
8	3406	1.06	3600.	440.	4040.	4198. (?)
9	3214	1.12 (?)	3600.	440.	4040.	4048.
10	1850	1.08	2000.	1590.	3590.	3581.
11	2900	1.03	3000.	905.	3905.	3910.
12	3905	1.02	4000.	130.	4130.	4144.
13	4000	1.00	4000.	130.	4130.	4140.
Total	37550	$1.048	$39400.	$11130.	$50530.	$50596.
				66.	66.	
Average unearned expense		0.298		$11196.		
Grand total		$1.346				$50596.

We can now see clearly that prorating the "actual" expense in each case, as was done in the former statement, gives absurd and misleading results, while by using standard rates we get intelligible results. The difference between the total weekly expense when running full ($1035.) and that when running at only twenty per cent capacity ($800.) is a reduction of $235, *due entirely to idle capacity;* therefore, to apportion any of this *reduction* to the active capacity would be wrong, and a seemingly arbitrary rate gives us a truer measure of cost than any other method.

The same data used in the first statement—Old Method of Treating Overhead—are rearranged in periods of four weeks each, and the overhead apportioned by standard burden rate based on "service," and not "output," as shown above in Table II.

One thing to be noted in comparison of this statement with the former is that, in an endeavor to make a cost "record" in June the bills for certain supplies were carried to July: the old method failed to show this up and gave no hint that August was relatively a high cost instead of low. Compare May to August, Table I, with 5 to 9, Table II.

This illustration, however, deals with the most elementary proposition, viz., one product carried through manufacture to completion within the cost period (one week).

With two or more products varying in process, and with portions of each remaining uncompleted at the close of the cost period, the problem becomes far more complicated and the results, under the old methods of cost finding, much more puzzling; while the superiority of the modern way of looking at costs becomes more manifest.

With the confectioner, making mixtures of candies which vary in cost from a few cents to several dollars a pound, or the locomotive builder, making a variety of types under the most diverse conditions as to demand, the case certainly presents "some problem."

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The great majority of practical managers and many engineers still hold one of two views as to cost systems: either,

1. That careful and systematic cost keeping is an exact science, the results of which may be accepted with confidence; or,

2. That, considering the practical difficulty of measuring all the variables introduced by fluctuating demand, varying efficiency, etc., etc., the only safety lies in a judgment born of experience in the particular business and amounting, in rare cases, to a sort of "sixth sense."

The greater number unhesitatingly take the first view, but it unfortunately happens that the second view is much nearer the truth where the problem is in the least complicated, the exceptions being the few instances in which the attempt has been made to base the system on sound principles.

Judging by the very few who achieve the "sixth sense" referred to (the writer has known but two or three), it seems that the majority of manufacturers would be somewhat in the dark as to the true meaning of their cost figures, *if their eyes were sufficiently opened to the facts.* That this is not the case, that they do not realize the very complex nature of actual conditions affecting costs (as usually computed), will be evident from the following.

Ask a thousand manufacturers if they really *know* their costs. With few exceptions they will resent this question, much as they would the one, "Do you know anything about your business?" They are sincere in resenting what they consider "rank impertinence" and entirely sure they do understand their costs.

In the endeavor to convince some of these sincerely self- deceived manufacturers that what they understand is the *method* and not the *results,* I have taken considerable pains to analyze a fairly simple but representative case, eliminating variables that do not bear directly on the main question, but retaining those which typify thousands of cases.

This illustration is a factory producing three classes of product (three types of a machine) which vary in the proportions of material and labor cost and also in the character of work and process. The three types sell for $10.00, $11.00 and $12.00 respectively. To simplify the matter as much as possible, the price of material, the rate of wages, and the respective selling prices have been calculated the same for each year; further, the variations in efficiency of operation have been eliminated, excepting, of course, the effects of changes in activity due to the varying volume of sales of the several classes.

In 1911, this factory ran at about two-thirds capacity, and in 1912 this was increased to four-fifths capacity through increased orders in about the same proportion as the year before. During these two years the costs were figured by a method in very general use among companies which prove their costs by the books and have their statements verified by public accountants; viz., Material and Direct Labor carefully accounted for and the expense added as a percentage to "Prime Cost." These costs showed the third class, "C," selling at $12, to be the most profitable, both per unit and in percentage of profit to cost. Based on this showing for two years, the sales of class "C" were increased about sixty per cent in 1913; the least profitable line, "B," was reduced ninety per cent, and class "A," being intermediate, was allowed a normal increase of something like thirty per cent.

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TABLE III.

Class Year	Number Sold	Material	Labor	Expense	Total Cost	Unit Cost	Price	Profit Each	Per Cent. Profit
A									
1911	3045	$17000	$3000	$6000	$26000	$8.54	$10.00	$1.46	17.
1912	3959	22100	3900	6916	32916	8.31	10.00	1.69	20.
1913	5186	28956	5110	9520	43586	8.40	10.00	1.60	19.
B									
1911	2692	16600	3400	6000	26000	9.66	11.00	1.34	14.
1912	3632	22370	4580	7168	34118	9.39	11.00	1.61	17.
1913	363	2241	458	755	3454	9.51	11.00	1.49	16.
C									
1911	3273	14400	9600	7200	31200	9.53	12.00	2.47	26.
1912	3928	17280	11520	7661	36461	9.28	12.00	2.72	29.
1913	6285	27648	18432	12877	58957	9.38	12.00	2.62	28.
Totals									
1911	9280	$48000	$16000	$19200 30%	$83200	$8.96	$10.70	$1.74	19.4
1912	11519	61750	20000	21745 26.6%	103495	8.98	11.00	2.02	22.4
1913	11834	58845	24000	23152 27.9%	105997	8.96	11.09	2.13	23.8

Although this policy did not greatly increase the total sales, it increased the proportion of higher priced and relatively more profitable product, and incidentally increased the proportion of labor which kept the men more fully employed throughout the year.

The showing for this year and the two preceding years, as calculated by the accountant according to the method explained, was substantially as shown in Table III. The results in each case were taken from the books and proved by the years' financial results.

The increase in total sales over 1912 was $4600, while the increase in total cost was but $2500, so that the increase in profit, of $2100, amounted to about forty-five per cent on the increased sales; a showing for which the "management" took full credit, after severely censuring the superintendent for allowing the ratio of expense to rise from 26.6 per cent to 27.9 per cent, a rise for which he could offer no excuse or explanation. The *average* profit increased from 22.4 per cent to 23.8 per cent, notwithstanding this increase in expense ratio.

But the Superintendent, smarting under what he believed to be an injustice, though unable to prove it, "went to school." He got some books on cost keeping, read up, and, at the next weekly meeting, demanded that a committee be appointed to look into the method of figuring the costs. As is usual in such cases, the man who made the trouble was put on the committee; the Superintendent and the Accountant got together several evenings and, at the next meeting, the Superintendent produced the statement, Table IV, in which the strictly manufacturing expense is separated from the commercial and selling expense and the former has been distributed on the basis of labor cost.

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TABLE IV.

Class Year	Number Sold	Material and Labor	Burden on Labor	Selling and Commercial Expense	Total Cost	Unit Cost	Price	Profit Each	Per Cent. Profit
A									
1911	3045	$20000	$2250	$2108	$24358	$8.00	$10.00	$2.00	25.
1912	3959	26000	2574	2571	31145	7.87	10.00	2.13	27.
1913	5186	34066	3066	3342	40474	7.80	10.00	2.20	28.
B									
1911	2692	20000	2550	2136	24686	9.17	11.00	1.83	20.
1912	3632	26950	3023	2697	32670	9.00	11.00	2.00	22.
1913	363	2699	275	268	.3242	8.93	11.00	2.07	23.
C									
1911	3273	24000	7200	2956	34156	10.44	12.00	1.56	15.
1912	3928	28800	7603	3277	39680	10.10	12.00	1.90	19.
1913	6285	46080	11059	5142	62281	9.91	12.00	2.09	21.
Totals									
1911	9280	$64000	$12000 75%	$7200 9.5%	$83200	$8.96	$10.70	$1.74	19.4
1912	11519	81750	13200 66%	8545 9.%	103495	8.98	11.00	2.02	22.4
1913	11834	82845	14400 60%	8752 9.%	105997	8.96	11.09	2.13	23.8

It will be seen that by this method, the expense ratio for 1913 is *less* than for 1912; the ratio of "selling" remaining unchanged.

The Superintendent contended that the Factory Burden should be measured by the labor cost (as above), and not by the "prime" cost as formerly. To this the Accountant would not agree and cited a number of the largest manufacturers in similar lines, whose cost systems had been installed by first-class accounting firms. The President was inclined to agree with the Accountant, but was considerably surprised by the latter's admission that *both statements absolutely tied up with the books for the three years!*

Finally, the Superintendent gained one point; that, as increasing the sales of class "A" would enable the factory to turn out more product, both in number of machines and total value, it was clearly the thing to do. To this the President assented, though far from convinced that the old way of figuring costs was wrong, but with his confidence in all sorts of cost keeping sadly shaken.

The sales of class "A" were accordingly pushed during the remaining eleven months of 1914; the sales of class "B" were, through active work, brought back to the volume of 1911; while, by putting on the brakes, the volume of class "C" was brought down to the amount of the former year. Meanwhile, a competent expert was retained to make a thorough study of conditions and install a method of measuring costs by "standards," worked out for the plant in question. The results of his study and analysis of the four years is shown below in parallel with the two former methods.

It will be seen that the second

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TABLE V.

Class, Price, Year	Number Sold	Costs by Methods					Percentages of Profit		
		Standard	3 Actual	* †	2	1	3	2	1
A—$10.									
1911	3045	$7.60	$7.73	$0.40*	$8.00	$8.54	29.	25.	17.
1912	3959	7.60	7.74	0.19*	7.87	8.31	29.	27.	20.
1913	5186	7.60	7.72	0.08*	7.80	8.40	30.	28.	19.
1914	11165	7.60	7.71	—0.02†	7.72	7.95	30.	30.	26.
B—$11.									
1911	2692	8.70	8.84	0.40*	9.17	9.66	24.	20.	14.
1912	3632	8.70	8.83	0.19*	9.00	9.39	25.	22.	17.
1913	363	8.70	8.99	0.08*	8.93	9.51	22.	23.	16.
1914	2692	8.70	8.92	—0.02†	8.82	9.00	23.	25.	22.
C—$12.									
1911	3273	9.65	9.82	0.40*	10.44	9.53	22.	15.	26.
1912	3928	9.65	9.81	0.19*	10.10	9.28	22.	19.	29.
1913	6285	9.65	9.82	0.08*	9.91	9.38	22.	21.	28.
1914	3273	9.65	9.82	—0.02†	9.80	8.87	22.	23.	35.
Totals									
1911	9280	Average	8.56	0.40*	8.96	8.96	25. — 5.6*		
$10.70							19.4	19.4	19.4
1912	11519	Average	8.79	0.19*	8.98	8.98	25.1 —2.7*		
$11.00							22.4	22.4	22.4
1913	11834	Average	8.88	0.08*	8.96	8.96	24.9 — 1.1*		
$11.09							23.8	23.8	23.8
1914	17130	Average	8.31	—0.02†	8.29	8.29	26.8 0.3†		
$10.54							27.1	27.1	27.1

* Unearned Expenses, kept separate from costs.
† Overestimated Commercial and Selling Expense, 1914.
Note: Material Cost, Wages and Selling Prices same each year.

method, Table IV, is, in this particular case, much closer to the truth than the first, Table III, which was wholly and dangerously misleading. In the years when the factory was operating at or near capacity, the second method runs very close to the third (and true) cost, taking into account the "unearned expense" which, in the second method is "lost in the shuffle" and averaged in with the cost.

The most interesting thing brought out by this comparison is the extent to which variations in cost (by existing methods), due to variations in plant activity, may completely mask and confuse the truth and lead to serious errors in judgment, unjust censure, and selling blunders requiring months or even years, to correct when finally discovered.

The strongest argument for the standard method, however, is not fully brought out by this statement, because, to simplify the matter, changes in the general efficiency of

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operations were eliminated, excepting the effects of changes in the activity due to more *orders*, the effects of which are clearly shown. In actual practice, of course, the efficiency of operations is constantly changing; and by having the cost of idle or unproductive hours clearly separated, as in the standard method, as "Unearned Expense," *any variation in the efficiency of work done is reflected in the costs.*

While the principles upon which the scientific method is based have been recognized for ten years, its introduction has been extremely slow. One reason for this is that, simple as are the principles, their application in actual practice is far from simple. The experience and painstaking work necessary to an installation are considerable, and unless the work is done *with an eye to the practical* at all times, the "system" is apt to be top-heavy or otherwise unsatisfactory.

Under competent guidance, however, it is entirely practicable to install such a system which will quickly prove its superiority both in value of results and in simplicity of operation.

For a number of years efficiency engineers have urged the superiority of measuring costs by standards, but have qualified it by stating that only an efficiency engineer can set up standards—a point we will not discuss here. Practical methods of meeting this requirement, together with the other essentials of a good cost system, have been slow of development.

A stone thrown at all cost systems by the so-called practical man is this: "Your costs are ancient history. I want *immediate* information." But this same practical man, when confronted by the question, "What can I do as to cost under such and such conditions?" at once goes to his "records" for something *near* the case, and "guesses" he can do thus and so.

To illustrate by the watch again: the old method would be something like this: "The last time I had to go to the B. station it took me twelve minutes *by actual record.* I can't make it in ten;" while the new, standard, and common-sense method will be more like this: "The B. station is six blocks. I can walk a block in a minute. If I don't stop to buy a cigar and a newspaper, as I probably did in the other case, I can make it in seven or eight minutes."

Among the lessons this sad world is learning from the present war are many dealing with efficiency, and not the least of these is the lesson that "preparedness" lies as much in organized knowledge and available information as in material things. That Great Britain has taken this very lesson to heart may be seen in the recent words of Lord Lansdowne, made in moving the second reading of the registration bill July, 1915.

"If there have been confusions, misdirected energies, great disappointments and if these things have resulted in disastrous consequences, this has not been due to a lack of patriotism or good will or skill on the part of our people, but to the defects of the machinery of our national organization, *to our failure to collect in good time the necessary knowledge, to marshall the facts, to take stock and to classify.*"

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PULVERIZED COAL—ITS PREPARATION AND USE IN INDUSTRIAL FURNACES

By S. H. Harrison

Advances in the utilization of fuels have not been confined to improvements in prime movers. It is well not to forget that large quantities of both coal and oil are consumed to produce heat and reducing atmospheres in a great variety of industrial operations other than the direct generation of power. For these purposes the use of powdered coal is increasing at a rapid rate. Some of its many applications and the technique of its handling are here set out by Mr. Harrison.—THE EDITORS.

DURING recent years the use of pulverized coal has attracted the attention of engineers, metallurgists, and chemists the world over, chiefly because of the highly economical results which have been obtained by the use of this kind of fuel. Another factor tending to increase its use has been the steadily advancing price of fuel oil. In some industries, notably the cement industry, where fuel oil had been formerly used, the saving effected by the substitution of powdered coal has been so great that the price of Portland cement has been reduced approximately fifty per cent.

As late as 1898, nearly all the Portland cement manufactured in this country was burned in rotary kilns which used oil for fuel. In those days the size of the rotary kiln varied from forty to sixty feet in length and in diameter from five to six feet. In order to burn one barrel of Portland cement clinker (380 pounds), approximately twelve gallons of oil were required. At a cost of five cents per gallon, the expense for fuel alone was sixty cents a barrel. Today Portland cement clinker is burned in modern rotary kilns at a fuel consumption of ninety pounds of pulverized coal per barrel; at a cost of $2.60 per ton of coal delivered in the kiln building in a pulverized state, the cost for fuel per barrel is 10.4 cents.

On the Pacific Coast, where oil is worth approximately 1.2 cents per gallon and the consumption per barrel of cement is about nine gallons, the fuel expense per barrel is almost the same as the fuel expense per barrel in the East, where pulverized coal is used. In the East, where oil is worth from four and one-half to five and one-fourth cents a gallon, its use in burning cement is prohibitive.

Pulverized coal was first used in England in metallurgical furnaces, and later applied, but without success, to the calcination of Portland cement materials. The endeavor to use it in the Portland cement industry remained dormant for many years, when, finally, the problem was attacked by American Portland cement manufacturers and was successfully solved by Messrs. Hurry & Seemans of the Atlas Portland Cement Company.

Portland cement manufacturers are the largest consumers of powdered coal in the world today. On account of the success with which this fuel has been employed in the cement industry, other industries investigated its possibilities, and we now

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find it used in the nodulizing of iron ores; in heating iron and steel products; in forging furnaces, etc.; in lime burning; in drying stone, clay, and other materials; in singeing cloth; and in the smelting and refining of ores and metals.

Coal Selection

It was found that the coal most desirable for burning in a pulverized state was bituminous gas coal having a volatile content of not less than twenty-eight per cent. The higher the volatile content, the more readily will the coal burn in the furnace and the easier will it be to ignite. Coals low in volatile matter, such as anthracite and semi-anthracite, are exceedingly hard to ignite and cannot be burned unless the furnace into which they are injected is in an incandescent state. The same condition is equally true for powdered charcoal.

The percentage of ash in the coal may or may not be beneficial to the resulting product of the furnace. A portion of the ash is carried out of the stack in a very finely divided state, but most of it, and especially the coarser particles, are readily collected in settling chambers provided for the purpose.

In the Portland cement industry, the ad-mixture of coal ash with the raw materials to be burned in the kiln may be beneficial to the resulting clinker, provided, of course, that the raw mixture is low in some particular constituent or constituents which the ash contains. At any rate, a coal having a high ash content has never acted as a detriment to the quality of cement produced. On the other hand, in other industries, a coal containing a high percentage of ash may cause the accumulation of slag in the furnace and interfere with the purity of the product manufactured.

The question of the effect of sulphur in the coal will depend upon the particular use to which the coal is put. The result may or may not be harmful. For instance: in burning pulverized coal in a reducing atmosphere, a portion of the sulphur may be burned to the dioxide form and a portion may pass through the furnace in a sublimed state. The sulphur in the sublimed state in a reducing atmosphere, or an atmosphere containing carbon monoxide, will combine readily with most metals in a molten state. If once the sulphur is thoroughly burned to sulphur dioxide and the atmosphere in the furnace is oxidizing, there is no tendency for the sulphur to combine with the molten metals in the furnace. It has been found also, in some cases where powdered coal has been used, that in allowing the stream of air and coal to impinge against the charge in the furnace, a quantity of coke is formed and the absorption of sulphur from this coke sometimes gives trouble. It seems that the best method to follow, where sulphur is a detriment to the materials in the furnace, is to burn the coal thoroughly in an oxidizing atmosphere at a sufficient distance from the charge so that nothing but the incandescent gases of combustion come in contact with the charge and the walls of the furnace.

It has been found also that the finer the degree to which the pulverization of the coal is carried, the more readily will the coal ignite and the more nearly will it assume the condition of an approximate gas when thoroughly mixed with air. To meet this condition, the coal should be ground so that at least ninety per cent will pass a 100-mesh sieve.

The moisture content should not be over 0.75 of one per cent. Pulverized coal containing a higher percentage of moisture has been successfully burned in industrial furnaces, but it is safe to say that dry coal should be

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used if continuously successful results are looked for. Pulverized coal in storage soon attracts a large percentage of moisture on account of its hygroscopic properties, and is apt to stick and clog up the device feeding it to the furnace. When a quantity of dry pulverized coal has been stored in uncovered bins, its absorption of moisture has been found to be so great that the excess water, settling to the bottom of the bin, leaks out at the corners. This occurs in places where the humidity is very high, as, for instance, in a room where steam is escaping from leaky pipes. It is well on this account not to store large quantities of pulverized coal, but to have on hand a sufficient quantity for a run not longer than twenty-four hours in a bin well covered and free from exposure to the surrounding atmosphere.

Furthermore, pulverized coal in a moist condition is not thoroughly atomized when blown into the furnace. Large lumps of a pasty mass of coal and water may form which may give rise to the formation of coke in the furnace as well as in the burner. The burner, in fact, may become so thoroughly choked with coke that the feeding of coal is interfered with and may lead to a shut down until the feeding apparatus is cleaned. The accumulation of coke in the furnace may build up so quickly that the draft passages will be obstructed and cause backfiring. Especially is this true in small furnaces.

From the safety point of view also, the coal storage should be kept as low as possible, especially when it contains a large percentage of sulphur. The writer has observed, especially when burning Indiana or Illinois coals in the powdered form, that spontaneous combustion almost invariably takes place when the sulphur content is two per cent or over. He has found that finely divided coal dust, settling on window frames, wooden girders, etc., even after an accumulation of only twenty-four hours would frequently take fire.

Perhaps one of the factors operating against the more extended use of pulverized coal is the belief, in certain quarters, that it is of an explosive nature and readily catches fire. Pulverized coal is not explosive until it is intimately and thoroughly mixed with air. For this reason, it is always better to convey the pulverized fuel by means of screw conveyors instead of transporting it through large pipes or ducts by a current of air. There are exceptions to this statement, however, which will be mentioned later on.

Several years ago, a large plant using pulverized coal had a disastrous explosion when they attempted to blow the fuel through large ducts by means of fans. This method of transportation should be condemned; a spark from a motor or from defective wiring may ignite this highly inflammable mixture. But where the pul verized coal is blown through comparatively small pipes and then separated in a sheet iron separator, a safe method is assured, and good and economical results will be obtained.

Some forms of coal dryers on the market allow the coal dust to accumulate in large settling chambers. These chambers are built either of brick or of sheet iron, but in both cases they are dangerous. Several explosions have occurred through their use, especially where bearings or journals in the interior of the settling chamber become heated, or where fire from a nearby furnace comes in contact with the mixture of coal and air. But the most frequent cause of trouble with dryers of the above type arises from the spontaneous combustion of the accumulated coal in the settling chamber.

Coal in the pulverized state, as pre-

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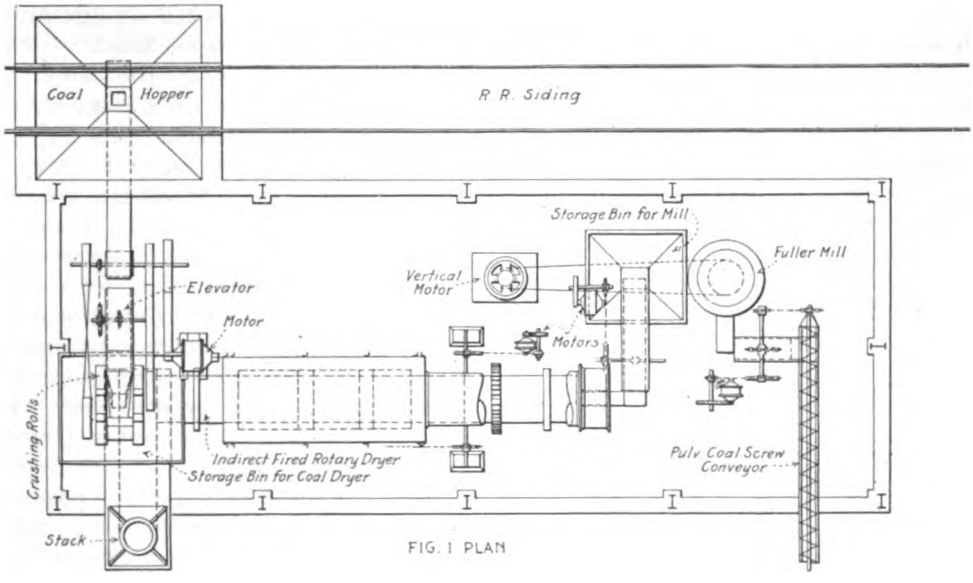

FIG. 1 PLAN

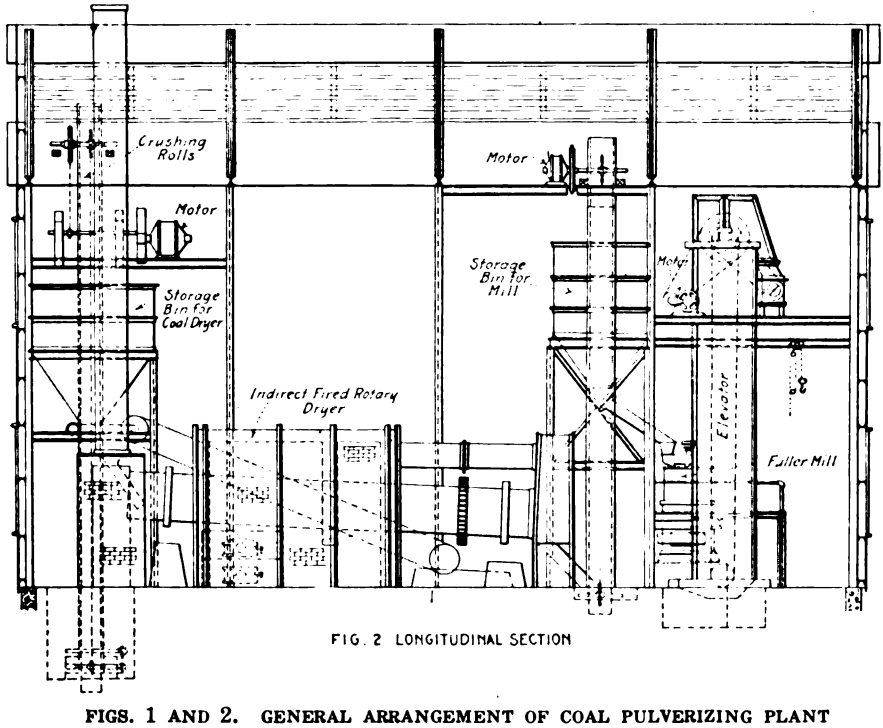

FIG. 2 LONGITUDINAL SECTION

FIGS. 1 AND 2. GENERAL ARRANGEMENT OF COAL PULVERIZING PLANT

viously stated, should be stored in metal bins covered with a tight sheet iron cover. The bin should be so constructed that it will readily clear itself when coal is removed from the bins to the furnace; that is, the bin should be free from all pockets or corners where the coal is likely to lodge and be kept in storage for a considerable length of time. Nearly all the fires in coal feeder tanks arise when this detail is overlooked, and trouble

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from this source is to be expected with defectively designed bins, especially where coal high in sulphur is used.

A typical analysis (dry basis) of a bituminous gas coal, suitable for burning in a pulverized form, would be as follows:

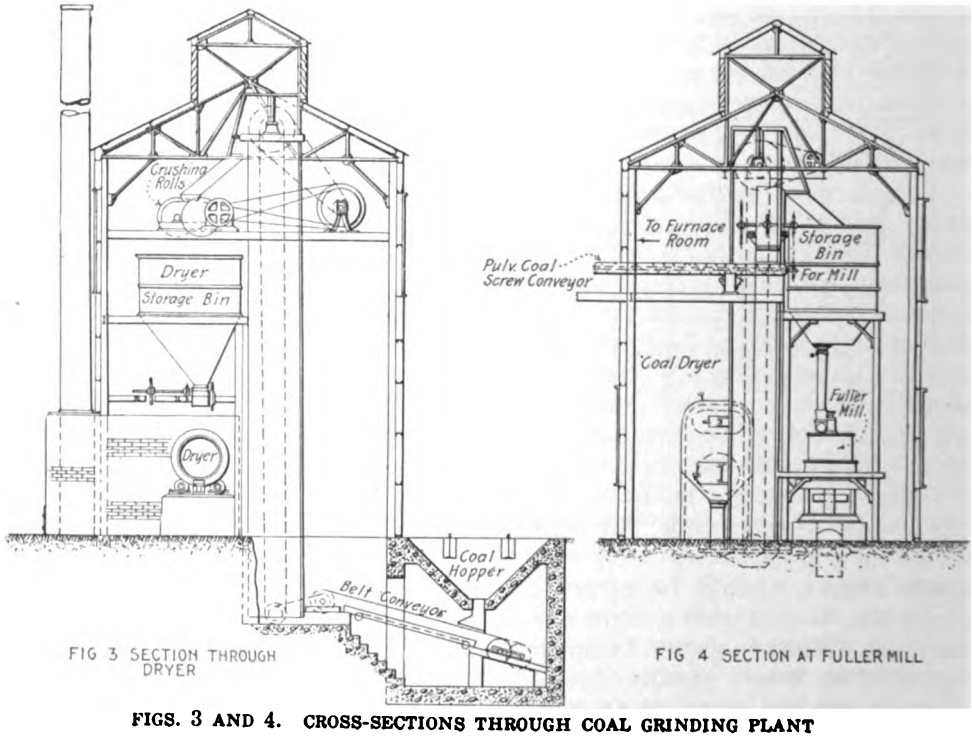
Volatile Matter.....	34	per cent
Fixed Carbon.....	58	" "
Ash	8	" "
	100	" "

The sulphur content should preferably be not over one per cent.

The Pulverizing Plant

Figure 1 shows the plan of a typical coal pulverizing plant. A siding for the delivery of gas coal runs parallel to the mill building. Coal is delivered in hopper-bottomed cars to a concrete coal pocket where it is dumped. It is then elevated to a set of crushing rolls located immediately below the elevator head. The crushed coal leaving the rolls is dropped by gravity into a large sheet-iron bin located above and at the rear of the rotary coal dryer. A suitable feeding device feeds the coal to the dryer. While passing through the dryer, the moisture is driven off and the dried crushed coal drops out of the lower end of the dryer into an elevator pit. It is then elevated again to a sheet-iron bin conveniently located over the pulverizing mill. In the puverizing mill the coal is ground to the requisite degree of fineness—namely, ninety per cent passing through a 100-mesh sieve—and then conveyed by means of a tight-fitting elevating and conveying device to the furnace room, where it is stored in its finely pulverized state in sheet-iron bins near the furnaces.

Figures 2, 3, and 4 are elevations of the typical coal grinding plant.



FIGS. 3 AND 4. CROSS-SECTIONS THROUGH COAL GRINDING PLANT

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Perhaps a better location for the rolls would be directly under the concrete receiving hopper. In this position they would rest on a firmer foundation than if they were placed on structural steel supports over the dryer.

Coal Burners

A number of burners have been placed upon the market, all of which are more or less satisfactory in the atomization of the powdered coal and the thorough mixing of it with the air. A burner which has been designed by the author and tried out in large and small furnaces, is shown in Figure 5. It consists of a device which thoroughly mixes the air and pulverized coal and, at the same time, accurately proportions both air and coal. Air under a pressure of about eight ounces to the square inch issues from the inner nozzle where it receives a rotary motion. The high velocity of the air issuing from the nozzle sets up a negative pressure in the vertical coal pipe which draws the coal forward and intimately mixes it with the air. A series of openings in the rear of the burner allows more air to enter and, at the same time, prevents coal from accumulating in the lower portion of the burner. A cleaning door is provided in the lower portion of the burner so that any accumulation of coal or foreign matter lodging at this point may be removed.

A number of burners have been designed to operate on compressed air at a comparatively high pressure, say thirty pounds per square inch and upward. Burners of this class are more costly to operate, on account of the comparatively high expense for operating compressed-air machinery, than are those which will operate by an inexpensive pressure blower, which furnishes air at from four to nine ounces pressure per square inch.

In one instance, the writer changed the burner system from a high-pressure system (sixty pounds per square inch) to a low-pressure system (nine ounces per square inch) and obtained a saving in power alone amounting to over $8,000 per year. The original system used a duplex steam-driven air compressor; the later installation used a couple of small inexpensive pressure blowers driven by electric motors and accomplished the same results.

Industrial Applications

Portland Cement:—The raw materials which are generally used for the manufacture of Portland cement are limestone and shale. These materials are pulverized to a high degree of fineness and are fed to large rotating cylindrical kilns.

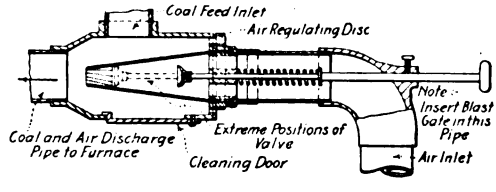
Coal Feed Inlet
Air Regulating Disc
Note:- Insert Blast Gate in this Pipe
Coal and Air Discharge Pipe to Furnace
Extreme Positions of Valve
Cleaning Door
Air Inlet

FIG. 5. TYPE "H-S" PULVERIZED COAL BURNER

Figure 6 shows a rotary kiln with the necessary appurtenances for burning Portland cement clinker. The modern rotary kiln is about eight feet in diameter and one hundred and twenty-five feet in length. It is usually lined with a fire-brick lining which varies from six inches to nine inches in thickness.

The kiln is given an inclination to the horizontal of about three-eighths to five-eighths of an inch to the foot. It is rotated at a speed varying from one revolution in one minute to one revolution in three minutes, and, on account of the inclination of the kiln, the material travels down the kiln in a zig-zag fashion until it is finally discharged at the lower end of the kiln.

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During its passage through the kiln, the raw materials are subjected to the intense flame from the incandescent powdered coal which is blown into the kiln by compressed air. The coal-feeding device opens into the kiln through a hood which closes the lower end. Space is allowed in the hood for the clinkers to drop through into the elevator pit below. Raw material is fed into the upper end of kiln by a screw conveyor or other suitable device.

The gases of combustion are carried away through the stack. The coarser particles of ash are caught in the brick settling chamber at the rear of the kiln. The kiln is usually driven by a variable speed motor. The speed of the kiln and also the rate of feeding raw material to it is varied by the operator to suit the conditions existing.

The clinker derived by this process, when cooled, mixed with a small percentage of gypsum, and then ground, is the ordinary Portland cement of commerce.

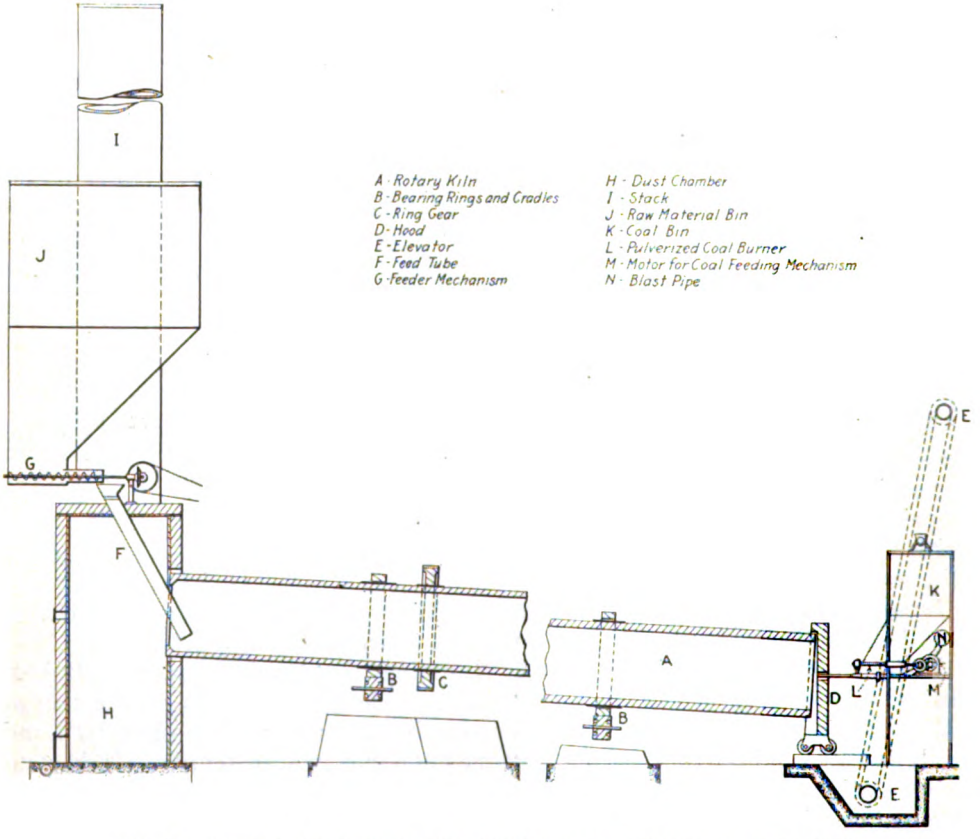
A - Rotary Kiln
B - Bearing Rings and Cradles
C - Ring Gear
D - Hood
E - Elevator
F - Feed Tube
G - Feeder Mechanism
H - Dust Chamber
I - Stack
J - Raw Material Bin
K - Coal Bin
L - Pulverized Coal Burner
M - Motor for Coal Feeding Mechanism
N - Blast Pipe

FIG. 6. ROTARY KILN WITH PULVERIZED COAL APPARATUS ATTACHED

Lime Burning:—Lime, used for the manufacture of hydrated lime, is now being burned in rotary kilns exactly like those used in the Portland cement industry. The limestone, instead of being fed to the kiln in a finely pulverized state, is simply broken up to a two-inch size or less. In some cases, even where a pure lime is necessary, as in the manufac-

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ture of calcium carbide, it has been found that the addition of such impurities as silica, alumina, and iron, introduced in the finely divided coal ash, is so small that their percentage may be considered as negligible.

This slight amount of impurities has been found with the draft pressure at the stack-end of a 125-foot kiln only one-fourth of an inch of water, the current of the combustible and other gases passing through the kiln being sufficient to carry nearly all of the fine particles of ash out into the stack settling chamber. In general, however, it may be stated that the greater the degree of fineness to which the coal is pulverized, assuming that dry pulverized coal is used, the less the percentage of ash impurity in the finished product.

Nodulizing Iron Ore:—Finely divided iron-ore is today nodulized in rotary kilns similar to those used in the Portland cement industry. The intense heat of the coal flame nodulizes the ore dust so that it can be readily handled, transported, and charged to the furnaces in its nodular form with the least possible loss.

Singeing Cloth:—In the textile industry, most notably in the manufacture of alpaca cloths, one of the processes to which this material is subjected is the singeing of the cloth. Ordinarily, this is done by passing the cloth rapidly over and in contact with a copper bar, heated to a bright cherry-red.

The cloth, previously wound on a roll, is passed over the heated bar and wound on another roll on the opposite side of the furnace at an average speed of twenty-seven feet per second. The rolls usually contain about 1440 yards of cloth about thirty-two inches wide.

The speed of the cloth over the heated bar is varied by throttling the valve on the steam engine connected to the winding rolls.

One firm had been using furnaces fired with fuel oil for heating this bar, and decided to find out if they could not use powdered coal at a considerably lower expense. The copper bar, in the case under consideration, was forty inches long, seven and three-eighth inches wide, three inches thick at the sides, and curving to a thickness of four inches at the

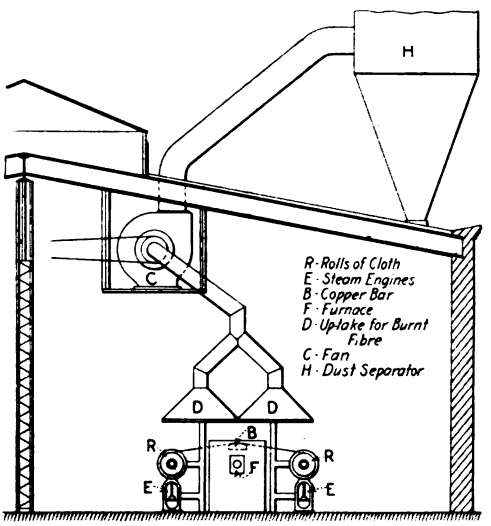

FIG. 7. FURNACE FOR SINGEING TEXTILES

center. A sketch of this furnace, showing end elevation and the bar, is given in Figure 7. The total length of the fire-box is approximately four feet. The furnace was connected to the stack by means of a flue, four inches wide by eight inches deep, located about three inches below the lower surface of the bar. The cross-section of the furnace, shown in Figure 8, was uniform throughout. It was found that any obstructions, like checker work or baffles, seriously interfered with the operation of the furnace and caused an accumulation of ash and coke which resulted in severe back firing. It was found that

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the coal ignited readily in less than ten seconds. The time usually required to bring the furnace up to its working temperature when using fuel oil was about thirty minutes, and the same result was obtained when pulverized coal was used.

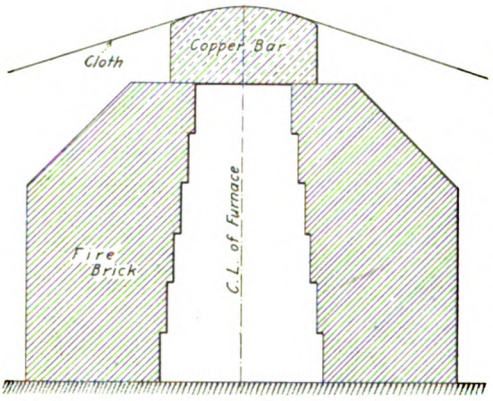

FIG. 8. CROSS-SECTION THROUGH SINGEING FURNACE

The copper bar, forming the upper portion of the furnace, is subjected to the direct heat of the flames in the furnace. A furnace, such as is illustrated in Figure 8, consumes 6.18 gallons of fuel oil per hour. The same amount of cloth was singed with a coal consumption of seventy-three and four-tenths pounds of coal per hour.

It has been found that to operate a number of furnaces of this kind with powdered coal, the cost of firing, including all labor, has been reduced approximately forty per cent.

This was the first time that the firing of a singeing furnace by means of powdered coal was attempted. It was believed that a furnace approximately four feet in length, requiring a coal consumption sometimes as low as fifty pounds per hour, could not be successfully fired with powdered coal, but this has been accomplished. The coal was perfectly burned; no clinker or soot was formed, and in four weeks of continuous operation the wear on the fire-bricks was insignificant. The smoke as it issued from the top of the stack was colorless, and, as the stack chamber had a sufficiently large cross-sectional area, most of the ash settled in the chamber at the base of the stack where it could be readily removed at the end of the day's run.

Iron and Steel Furnaces:—Figure 9 shows a pulverized fuel feeder arranged to heat the furnaces of a recently erected iron mill.

Primary air is furnished to the burner mainly for the purpose of injecting the coal into the furnace. In this arrangement there is not sufficient air entering through the pri-

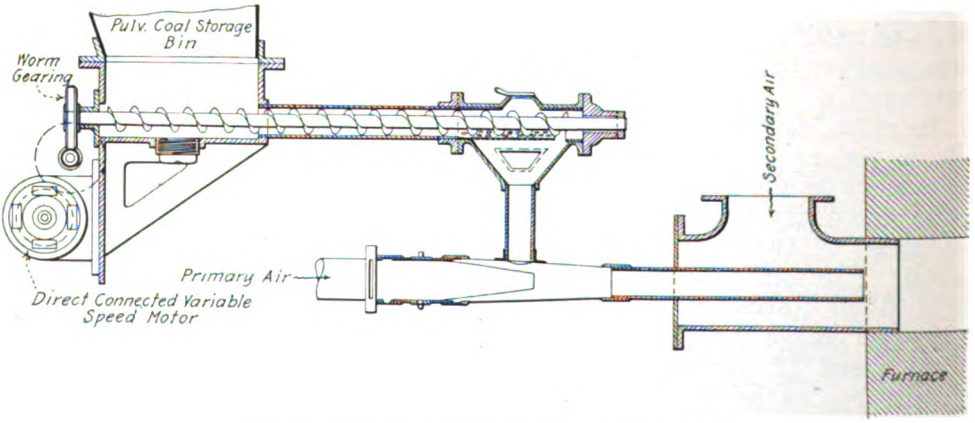

FIG. 9. FEEDER INSTALLED IN AN IRON MILL

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mary pipe to maintain combustion, and accordingly a large secondary air inlet is provided which allows air to enter the furnace at the low pressure of about two ounces to the square inch. Before the secondary air is supplied it is heated by means of waste heat from the furnaces. The screw mechanism for feeding the fuel is driven by a worm wheel and worm, encased in an oil-tight casing not shown in the figure, direct connected to a small variable speed motor. The motor is securely bolted to a bracket directly below the feed screw, and the rheostat, used for controlling the speed of the feed screw, is located at a point convenient to the operator.

Besides the applications of pulverized coal already described, there are numerous other cases where this fuel can be is used. One of these is in the smelting and refining of metals in reverberatory furnaces, where this fuel has already taken the place of gas or oil.

Grinding Methods

In the early part of this article, attention was called to the fact that pulverized coal should be transported in a bulky condition, and not conveyed from point to point by blowing it through large ducts or pipes where it would be liable to come in contact with electric sparks, or over-heated bearings, or where a sufficient amount of powdered coal might accumulate in pockets or crevices to cause spontaneous combustion. These remarks apply only to the manner of transporting the coal and not to any system of grinding on the market today where air separation is used.

A safe and economical way of

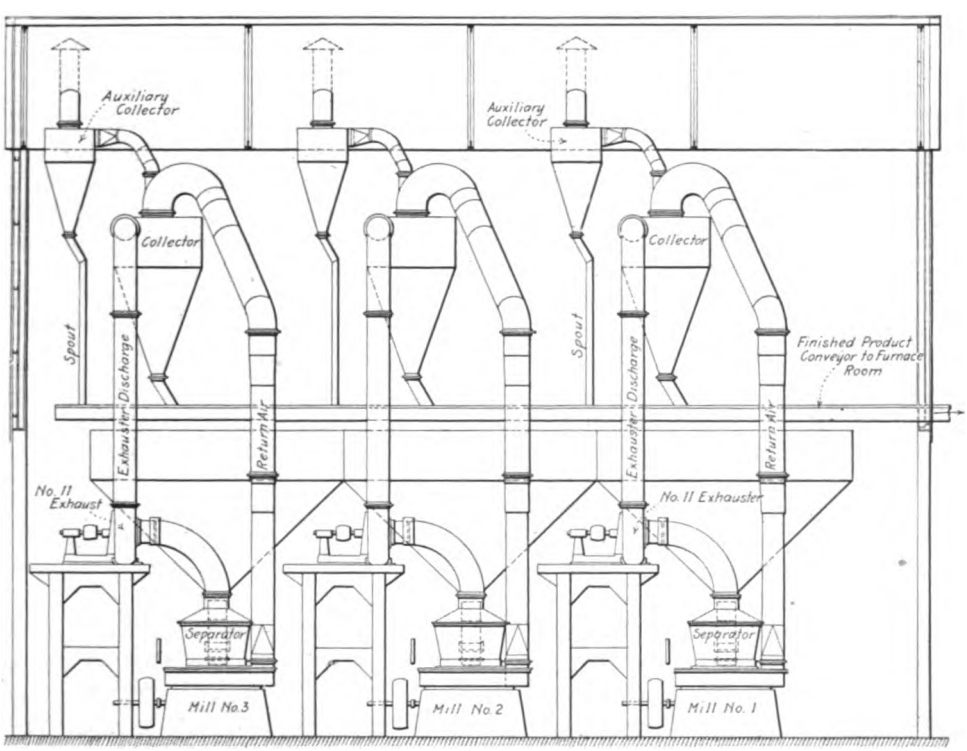

FIG. 10. BATTERY OF RAYMOND MILLS

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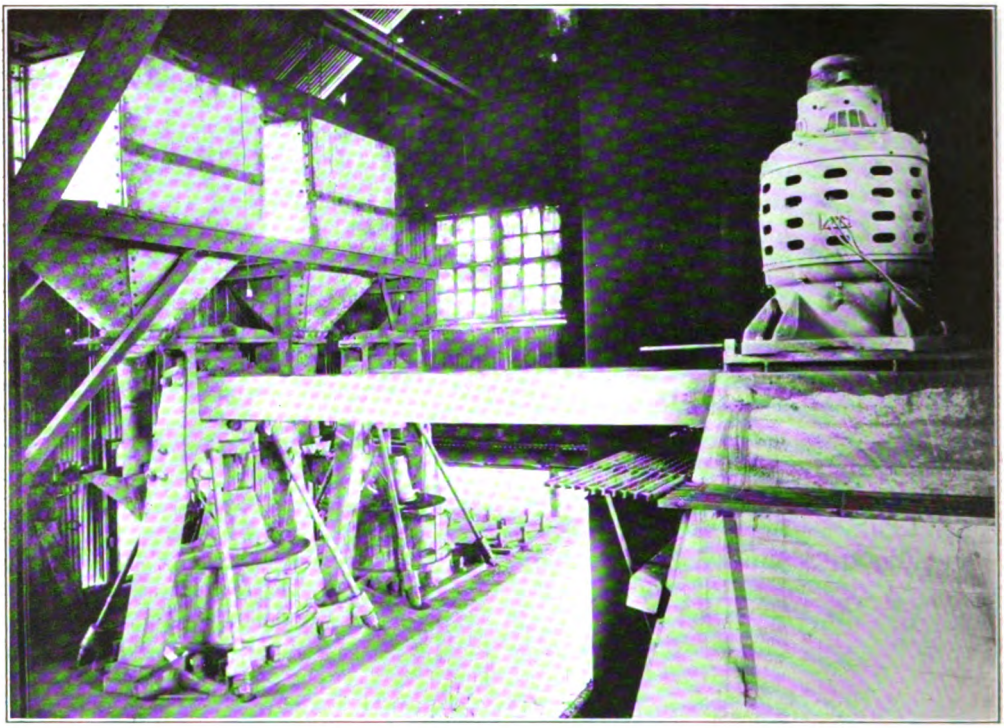

FIG. 11. GRIFFIN MILLS FOR COAL GRINDING IN CEMENT WORKS

grinding coal is employed in the Raymond system. The fine particles of coal produced by the grinding are carried upward in comparatively small sheet-iron pipes, free from any agencies which may tend to ignite the coal, and separated from the air into so-called cyclone separators which empty directly into a bin or screw conveyor. By this means an elevator in connection with the grinding mill is dispensed with and the coal is directly elevated by means of the air pipes instead of a chain and bucket elevator.

The separator is comparatively small in volume and on account of its conical shape offers no chance for coal to become trapped in it.

Figure 10 shows a battery of three Raymond mills of the type described, arranged for pulverizing bituminous coal. A portion of the coal dust in the discharge air from the main collectors or cyclone separators is carried into an auxiliary collector or separator before being discharged into the finished product conveyor leading to the furnace room.

The typical coal grinding plant shown in the drawings is the Fuller mill. This is a very popular and compact mill and is very largely used for preparing pulverized coal.

A very compact coal grinding room is shown in Figure 11. It consists of a battery of Griffin mills driven by vertical motors. This installation is at present in use at the works of the Cape Girardeau Portland Cement Company, at Cape Girardeau, Mo.

Advantages of Powdered Coal as Fuel

The cost of labor in a pulverized-coal furnace room is greatly reduced, due to the fact that one man can

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easily attend to six or more furnaces, depending of course on their location. The labor of ash removal is also very largely eliminated. On the other hand, labor must be employed in grinding the coal, not to the extent, however, of off-setting the advantages gained in the furnace room.

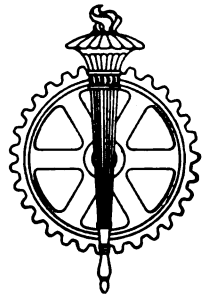
Another fact that must not be lost sight of is that the coal is completely burned and the smoke nuisance is abated. And, if the stack chamber and flue passages have been properly designed, the fine ash can be collected in settling chambers at the base of the stack. An analysis of the fine ash resulting from the combustion of pulverized coal shows no presence of combustible matter, where in ordinary furnaces the combustible matter in the ash may run over forty-five per cent, depending upon the burning qualities of the coal.

The fire in a pulverized coal furnace is under the instant control of the operator. The flame can be entirely shut off and the fire started again in a few minutes. In some cases considerable economy is effected by doing away with the banking of fires during idle hours, the furnaces being started up upon demand.

But the principal factor tending to increase the use of pulverized coal is its relatively low cost in comparison with other fuels. For instance, if a ton of coal having a heating value of 14,000 B.t.u. per pound, costs $2.60 delivered to the furnace bins, the cost to produce one million B.t.u. would be 9.3 cents. If fuel oil. having 20,000 B.t.u. per pound, is worth 5¼ cts. per gallon delivered to the furnace room, the cost to produce one million B.t.u. would be 33.7 cents.

Of course, the cost of grinding one ton of coal will depend upon the total quantity of coal to be ground. In some of the large Portland cement plants which use coal at the rate of one hundred and fifty tons per twenty-four hours, the cost of grinding the coal and delivering it to the furnace bins does not exceed forty-five cents per ton.

In view of these manifold advantages, pulverized coal is rapidly taking the place of more expensive kinds of fuel, and each day we find it being applied to a greater number of industrial furnaces.



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TRAINING MECHANICAL APPRENTICES AT THE NORFOLK NAVY YARD

By N. E. Adamson, Jr.

OUR Navy Yard at Norfolk, Virginia, is primarily a repair plant for naval vessels. New construction work has so far been confined to such vessels as tugs, ash lighters, coal barges, and like craft. A large number of articles regularly used in the navy are manufactured, and the manufacture of these standard articles form the bulk of the work performed inside some of the shops. Such articles as powder packing-cases, gasoline engines, paints, paint drums, ditty boxes, small boats, etc., are manufactured.

The number of men employed is constantly varying and depends largely on the number of vessels at the Yard for repairs. The normal force for the shops numbers about 2000, and of these there are about 80 young men serving apprenticeships in the trades. There are eleven large shops which comprise practically all af the trades essential for the purposes of a navy yard, but many of these trades consist of relatively few, easily learned operations, and therefore do not require apprentices. Apprenticeships are being served in the trades of patternmaker, moulder, machinist, toolmaker, sheet metal worker, shipfitter, shipsmith, shipwright, joiner, boilermaker, plumber, pipefitter, coppersmith, and electrician.

ENTRANCE REQUIREMENTS, PROMOTIONS, AND PAY

There are "Navy Instructions" which prescribe certain requirements for all apprentices and applicants for apprenticeships. Briefly, these are that upon appointment the apprentice must be between the ages of 15 and 18 years. His pay on appointment is 20 per cent of the maximum wages of a journeyman workman in the Yard at the trade. On appointment he is known as a fourth-class apprentice, and at this rating and pay he remains for at least six months, when he may be promoted to the rating of third-class apprentice with the pay of 30 per cent of the maximum wages of a journeyman workman in the Yard at the trade. At this rating and pay he remains at least six months, when he may be promoted to the rating of second-class apprentice with the pay of 40 per cent of the maximum wages of a journeyman workman in the Yard at the trade. He then remains a second class apprentice for at least a year, when he may be promoted to the rating of first-class apprentice and receive 50 per cent of the maximum wages paid a journeyman workman in the Yard at the trade. After serving one year as a first-class apprentice, and after having reached his twentieth birthday he may be given the lowest wages of a journeyman workman in the Yard at the trade, and at the close of one year's service at this rate, his apprenticeship is honorably closed and a suitable "apprenticeship certificate" is awarded.

SEMI-ANNUAL EXAMINATIONS

During the first week of June and the first week of December, a Board

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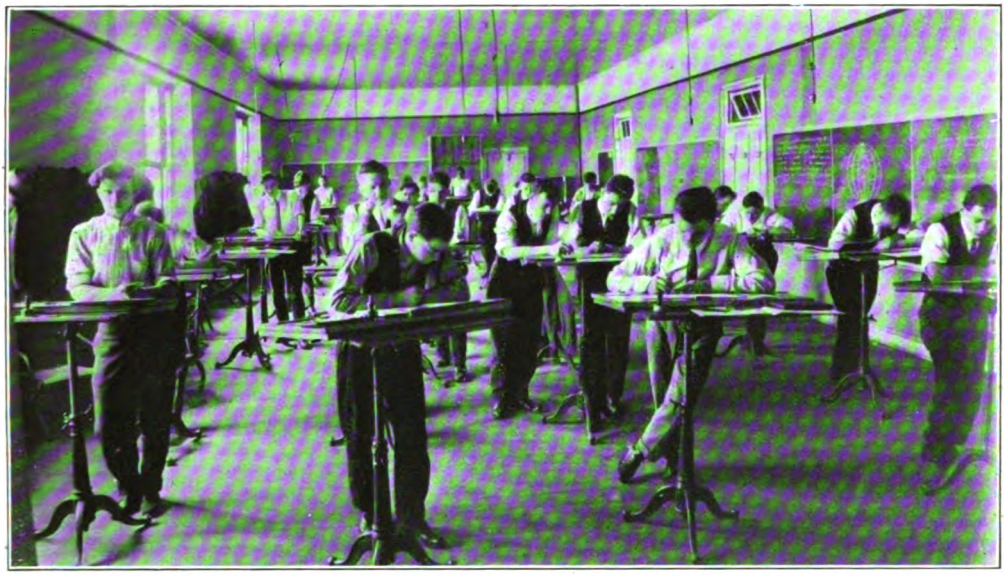

A CLASS IN MECHANICAL DRAWING—APPRENTICE SCHOOL

of Naval Officers is appointed to examine all the apprentices, and to make a recommendation, based on the results from the examinations, as to the promotion, retention in present rating, or discharge of each apprentice. This Board proceeds to conduct physical examinations, written examinations in the trades, written examinations in arithmetic, examinations of the individual's records in the shops and the school, and an examination of the attendance records and conduct records of each apprentice. The recommendations of this Board are invariably approved and the action recommended carried out.

Prior to 1910, the Examining

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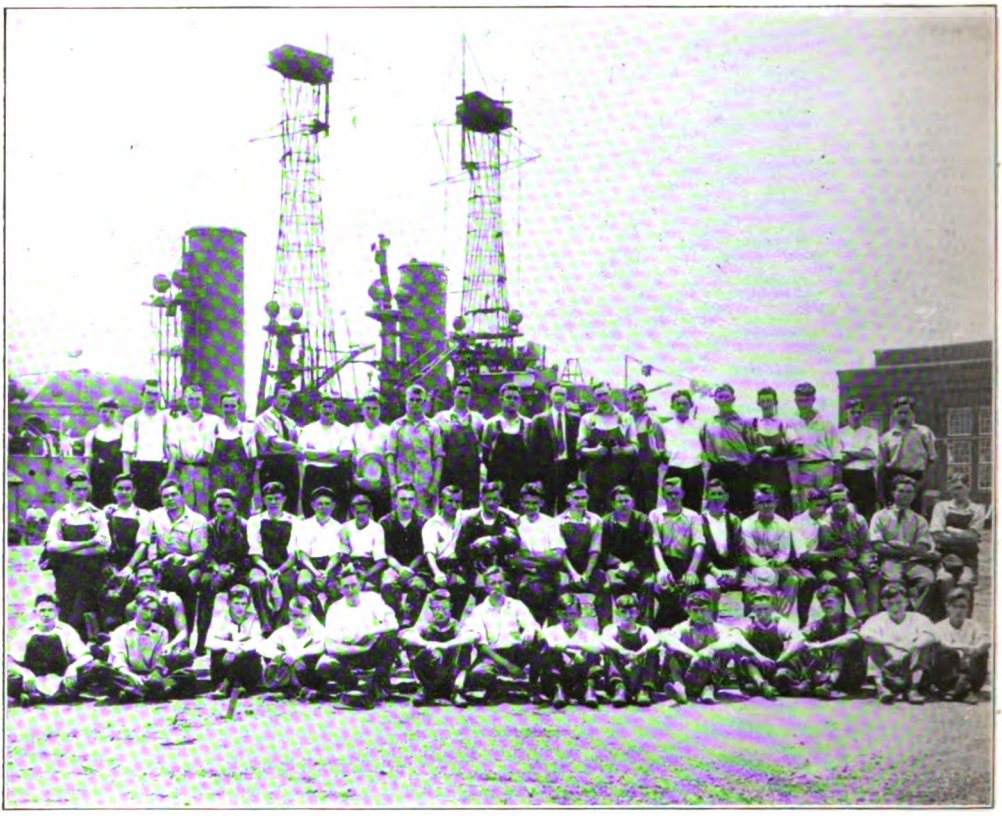

A GROUP OF APPRENTICES

Boards had no information as to what scope the examinations should have, and the apprentices were at a loss to know what subjects to study in order to meet the requirements at these examinations. Often questions on academic subjects which were too advanced were used, which, of course, had undesirable results. During 1910, the Navy Department issued an outline of study for apprentices which consists of the various processes in arithmetic, beginning with the fundamental operations with integer numbers and extending through decimal and common fractions to and including problems in mensuration, involving the finding of the cube root. A requirement was specified for apprentices in each rating, and this requirement had to be learned before an apprentice could obtain promotion.

The Apprentice School

The furnishing of the outline for study was followed by much better results on the semi-annual examinations. It developed, however, that many of the apprentices who were doing excellent work in the shops were apparently not capable of learning, without assistance, the arithmetic which was required. It also developed that a majority of the apprentices, on the completion of their apprenticeship, could not make sketches or read blue prints of the most elementary kind pertaining to work in their trade. After much investigation as to costs, methods of training apprentices at large shipyards and railroad shops in the United States, and methods of training apprentices

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in the navy yards of other nations, an apprentice school was started at the U. S. Navy Yard, Norfolk, Va., on January 2, 1913.

The school is located in a large room fitted with adjustable drawing tables, blackboards, maps, and other equipment useful in teaching arithmetic, spelling, grammar, geography, sketching, and mechanical drawing. The Shop Superintendent has supervision over the school, but draftsmen and mechanics who have had sufficient academic training are used as instructors. Each apprentice is given one and one-half hours per week instruction in arithmetic, and each apprentice above the rating of fourth-class apprentice is given, in addition to the instruction in arithmetic, four hours per week instruction and practice in sketching and mechanical drawing. The instruction in the other subjects named is given as supplemental to the instruction in arithmetic, sketching, and drawing. The Government furnishes all the equipment and instruction free to the apprentices, and pays them for the time spent in the school the same as for the time spent at work in the shops. In fact, apprentices are taken from their work in the shops or on ships and are sent to the school during the regular forenoon working hours. No text books are used by the apprentices, and home study is not required.

It has been found impracticable to fix a relation between the instruction in the school and ratings of the apprentices. Some of the apprentices on appointment have had a high school education, while others have not completed their course in the grammar schools. The apprentices are therefore grouped for instruction in arithmetic with respect to their knowledge of that subject. The semi-annual written examinations in arithmetic are based on the work covered in the school, so that there is now no cause for a failure on the arithmetic examination except extreme dullness, lack of attention to instructions, or laziness. There are five groups reporting to the school for instruction in arithmetic, group No. 1 being the least advanced, and group No. 5 being the most advanced. When an apprentice has completed his school work in group No. 5 and has passed the semi-annual examination on this work, he is graduated from the school and his apprenticeship, so far as academic requirements are concerned, is completed. Here it may be stated that the arithmetic taught in the school pertains particularly to the trades represented, and all processes, such as compound interest, insurance, etc., which are not useful in the trades are omitted.

The instruction in sketching precedes the instruction in mechanical drawing, and consists of copying plates until straight lines, and regular and irregular curves can be readily made free hand; then sections of pipe fitting and machine parts are made from the objects. The mechanical drawing is mostly elementary and is given to develop a knowledge of projections and development of surfaces. Through this training apprentices are taught to read blueprints.

Training in the Trades

The training in the school occupies about one-ninth of the working hours of an apprentice, so that eight of every nine working hours are spent either in a shop or on a ship doing production work. When an apprentice first enters his course, he is given light work where he can best get an idea of the general nature of the trade he is desiring to learn. At any time during the first six months he can resign, but when he has been at work six months he cannot resign except for reasons which are satisfac-

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tory to the Government representatives.

As above stated, most of the work at the Norfolk navy yard is repair work, and the nature of the work is constantly changing. Therefore, it is impossible to standardize the shop or trade training of an apprentice. The nearest approach to this that has been accomplished is the keeping of a chart which shows the types of machine tools across the top, and the names of the apprentices along the left margin. The periods during which an apprentice is operating a machine tool are entered opposite his name under the type of the machine tool he is operating. By constantly referring to this chart it is possible to shift apprentices from one machine to another, allowing only sufficient time at any one machine to become reasonably skilled in its operation. In trades, such as the shipfitters' and electricians', where but few machine tools are used, the training consists mostly of assisting the best mechanics in the trade. These apprentices are shifted from one mechanic to another, thus learning more of the trade than he would probably learn if he assisted one mechanic throughout the apprenticeship. Whenever an apprentice has sufficient skill to perform small jobs on ships without the assistance of a mechanic, he is tried out on such jobs. The leading man under whom he works furnishes him instruction while on such jobs. The training in the trades is under the supervision of the foremen who, at the end of every three months, report in writing to the Industrial Manager the progress which each apprentice has made in the trade and the conduct of each apprentice. These quarterly reports are given consideration at times of semi-annual examinations. The semi-annual trade examination questions pertain to work on which the apprentice has been engaged.

Through the frequent reports and examinations, it is possible to find out which boys are indifferent to their work, and to take the necessary action to correct their attitude. When an apprentice fails on his semi-annual examination, he is not promoted, and ne is warned that a failure on the next examination will result in his discharge. He then has six months in which to become familiar with the subject in which he has failed, and ne is given ample opportunity, as will be noted from the above, to prepare for the next examinations. Generally, when an apprentice fails after being warned, it is a sign of hopeless indifference or rare dullness, or both. Such apprentices are discharged.

The Physical Examination

The physical examinations, which are a part of the semi-annual examinations, are conducted by a U. S. Naval Medical Officer, and are always thorough. The apprentices are informed of their physical defects and of how they may be corrected. If the defects can be corrected, and are such as will make the boy more liable to accident if not corrected, a correction is required. For example, cases have occurred in which hernias had developed unbeknown to the possessors, and the boys were working in ignorance of their danger.

This constant training and examining of apprentices result in the obtaining of a general excellence in the physical and the mental condition of the young men who are being passed up into the trades. It is to such men that the Government looks when seeking men for supervising positions in the trades.

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THE FUTURE OF THE WORLD'S METAL SUPPLIES

By Donald M. Liddell

Final decision in the Great War will rest not on men or money or food supplies but on industrial efficiency, such is the opinion of one keen observer. But industrial efficiency implies not only the best use of natural resources, especially metals, but also their possession. Consequently, every belligerent nation and every neutral one of consequence has since August, 1914, been taking stock of its mineral wealth in the attempt to forecast its industrial and political future. The question of real conservation, that is manufacturing efficiency, has never loomed so large as now, both nationally and internationally. What resources of metals has this Earth, how long will they last, what will we do when they are vanished? Mr. Liddell analyzes the existing situation with the acumen sprung of accurate knowledge and the conclusions he draws will be of the greatest interest to all.—THE EDITORS.

THERE are but few pleasures which compare with that of telling other people what to do with their own property, but one of the rivals is that of preserving valueless or easily replaced goods, of which the garret is a mild and well nigh universal manifestation. Another and more virulent form is that known as "conservation of natural resources," since that allows one to indulge in both of these delights at once—in still other cases the devotee of these forms of dissipation goes in for cutting down infant mortality.

Why do we allow forests to decay rather than cut them for lumber? Why do we preserve the waterfall unharnessed for the "enrichment of a future generation of common people," when all of the present generation would be the gainers by its use? And when will mental inertia, which is as real a factor in life as is physical, allow the conservationist to see that the things truly to be conserved are not fresh crops of babies destined never to have a chance in the life they are preserved to, but in the best use of the world's mineral resources. Bare existence rests mainly upon a cuticle of upper soil two feet thick; were the earth denuded suddenly of that, most of its inhabitants would perish. Civilization rests upon a skin perhaps two miles in depth, and when its mineral stores are gone, whence will they be replenished?

Forests replace themselves in thirty to fifty years; the world's minerals are the result of geologic ages in which the growth of a forest is a second's tick, and once gone, they have gone forever. How are we using them? The unthinking view, which is the common one, is that the metals we have so hardly won are perpetually added to the world's stock. Nothing can be farther from the truth.

Tin has long been one of the favored metals of man, since the Phoenicians braved the seas beyond the pillars of Hercules to obtain it, or Achilles led his bronze-mailed Myrmidons against Troy. Three thousand years have gone, and it is still so scarce that in a few months, as in 1913, the machinations of a Jewish-Chinese syndicate can send the price up by twenty per cent. The tin going on our tin cans, which is the bulk of the output, is now almost

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totally lost. With what the metal receptacles for food of a decade hence will be lined, is already a problem. It has indeed now been found that Bolivian tin can be freed from its arsenic and used for a time, but the Bolivian deposits must some day suffer the fate of the British and the Straits Settlements. *Ores do not grow by sensible increments.*

Perhaps we may extend the use of the detinning process, but some tin cans will escape, and there are still tinned copper wire, tin foil (which aluminum is already beginning to replace), small medals, tin-coated roofing, which wears out in use, and alloys which suffer ultimate economic destruction, as the white alloys used in coffin trimmings, to be reckoned with.[1]

Lead was unquestionably known to the Egyptians, the Romans apparently understood its desilverization, yet we are apparently already entering on an era of permanently higher prices. The world's accumulated stocks of 5000 years seem powerless to help us. How can they, when every rain washes lead paint from the houses into the ground in a form too disseminated ever to be regained; when every soldier fires away a portion of the world's stock[2]; when almost every coffin carries a lead lining; while lead pipes or lead joints in iron pipe corrode in the ground; and when every plumber's apprentice throws away lead dross; and tea is packed in lead foil? In the meanwhile, the increasing use of lead in storage batteries adds another possibility of loss. The sludge from these batteries will usually be thrown away when the cells are cleaned. And so the new discoveries of science help to add new methods of waste.

The production of lead has risen from 297,570 metric tons in 1873, to 1,186,700 in 1913[3]. Some time ago I calculated[4] that if the consumption of lead increased in the same ratio for the next few years as it had in the past, that in 1920 we should need no less than 1,359,300 metric tons. This figure will probably not be attained and the near future should see declining production and enhanced prices, with a consequent readjustment of economic and industrial conditions of great importance but at present unpredictable in either intensity or direction.

Copper has an ancient and honorable history, beginning with Genesis 4:22; yet with this metal, the modern electrolytic refining process and the electrical industry which made each other mutually possible, have so altered conditions that it is perhaps not fair to judge from accumulated stocks and ancient and medieval production. That is, electrolytic refining has rendered copper deposits profitable which before were too impure to be of any account whatever with the old furnace refining, while the electrical industry has created a demand which could never have been imagined in the wildest moments of the copper producer of the middle Nineteenth century. In addition, copper store fronts, cornices, leaders and gutters, augment the demands on this metal. A single New Jersey factory of up-to-the-minute design has 21 miles of copper flashing, gutters and leaders, while it seems probable that at present at least 225,000 metric tons yearly is going into munitions of war.

[1] *The Mining Journal* (London), Oct. 11, 1913, p. 979.

[2] Twenty-eight tons of lead were recently recovered on the grounds of a popular gun club; how much more was probably lost? What is being lost on European battle-fields we cannot in the slightest degree calculate.

[3] "The Mineral Industry," Vol. II, p. 382; *Engineering and Mining Journal*, Jan. 9, 1915.

[4] *Engineering and Mining Journal*, Apr. 12, 1913.

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Copper production has climbed a fairly steady grade from 1879 (154,376 metric tons) to 1912 (1,004,844 metric tons). I calculated[4] in 1913 that in 1915 we should require 1,176,100 tons, in 1920, 1,606,700,

The 1915 figure was not attained; where that of 1920 will come from, even under normal conditions, I do not know. Even if Braden and Chuquicamata in Chile, and Katanga in Africa, yield their promoter's dreams, they cannot make up the difference. Though other deposits be discovered, a great copper producer is not made in a day, nor a year. It is my belief that by 1920 even the prevailing rate of increase will be checked, which means that copper also will have entered a stage of permanently higher prices. In the meanwhile, shells continue to carry their copper bands, the trolley wires of the world are subject to a startlingly rapid abrasion, all going to unrecoverable dust, while the ash and garbage dumps of each city show a sad amount of small scrap copper—too small even to attract the Italian junk picker, but great in the aggregate—to give the answer to the idea of a permanent addition to the metal supply of the world.

Zinc was known in alloys from the earliest times, its recovery as a pure metal is only a matter of about 300 years. Nevertheless, we should have accumulated a comfortable amount, since it is estimated that 20,000,000 tons have been produced in the last forty years. Yet, as with lead, every rain washes an appreciable amount of zinc paint into the ground, cartridge shells require zinc as well as copper, and every salammoniac electric battery renders some zinc commercially non-existent. So too, innumerable miles of barb-wire fences, and uncountable acres of galvanized sheets and pipe, waste zinc that iron may be preserved. Small things, indeed, but many of them. However, zinc, thanks to improved metallurgy, has not yet seen its flood tide—it is too early yet to indulge in Jeremiah's lamentations, yet zinc deposits cannot be inexhaustible.

The reports of the magnificence of the Middle Ages do not seem to show much increase over the treasures in the Egyptian Labyrinth, or of the wealth of Croesus. However, in the last fifteen years there has been added to the world's stock a quantity of gold greater than the amount before known to exist in the modern world. Against this has been an absorption in India from 1891 to 1900 of about $135,000,000; from 1901 to 1910 about $400,000,000; in 1913, probably $150,000,000 in gold disappeared there. The silver absorption of India is estimated at $2,065,000,000 during the 70 years ended in 1910.

Certainly, though the gold output amounts roughly to 800 tons per year, the silver to 8,300 tons, there seems to be no sufficient increase in the world's stocks to correspond. Whether the hoards of India could solve the question is arguable, but I think they could not. Each year our dead take a tremendous toll of these metals under ground in an utterly unrecoverable form. Certain nations of antiquity wiser than we, limited the precious metals interred to the fillings of teeth,—we may some time again rise to that standard.

The Eastman company alone uses about 110 tons of silver a year in photographic goods, and it is by no means the sole maker of them. Of that silver finding its way to the amateur photographer, or the professional either, how small a proportion ever finds its way back to commerce. Lost—forever—in a million ash heaps and sewers. The basing of the world's coinage on gold and silver, to which I shall animadvert un-

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der gold, is responsible for the burial of a vast quantity of these metals. We still dig up Roman hoards; who shall dig up ours, and how many shall go forever undiscovered?

To return to gold, the basis of so-called civilized financial systems, the foundations of its relics of savage adornment, and an otherwise comparatively useless metal, its curve of production, owing to the vigor with which this metal has been sought since Solomon sent his caravans into Africa, had come down to a fairly dead level by 1870, about $100,000,000 per year. In 1889 the cyanide process began operating commercially and production went by leaps and bounds to its present figure of about $465,000,000 yearly.[6] Apart from the amount interred spoken of above, buried in forgotten hoards and lost in ashes of our conflagrations, an enormous amount of gold disappears yearly by the abrasion of coinage, and each marine disaster takes a sensible quantity from man's reach—but we have not yet become civilized enough to use only paper money founded on gold bullion. And so it was that when the South African miners struck in 1913, the world of finance scarce dared to think of the results of a long-continued curtailment of the Rand's output.

Shushanna may turn out another Klondyke, Ungava may show another Porcupine, Spitzbergen may develop another Rand, yet so far as the mining engineer can see, the crest of the world's gold production has been reached, and 1920, instead of the $520,000,000 production which should be found to meet the world's desires, will doubtless only see us at about $465,000,000, our present figure, or already on the down grade. There is, indeed, some reason to believe that the crest has already been passed, and that gold production is already on the decline.

What this means is of a more than transient interest. Will another process as revolutionary as the cyanide loose another flood of gold, as more than one economist has termed the output of the last quarter century? (Truly the flood has been lost in a thirsty desert). I think not. There is not a chance to cut the figures of cyanide costs, as did cyanide cut the costs of smelting and chlorination, for it more than halved them. And most of the present cost of the cyanide process is in mining and crushing the ore. Will we find a process to treat a mountain of ore *in situ*, without even mining it? The everyday things of today are the impossibilities of yesterday, but on this last question we have some doubts.

Will a declining gold production lead to a universal fall in textiles and provisions and labor, so that much more work can be put on the unpayable ore of today, say that below a value of $2.50 per ton? Perhaps so, to the intense joy of the bond holder whose obligations run for a century to come, like some railroad bonds, or do not mature at all, like the British consols and some United States bonds, for their obligations, or the interest on the irredeemable securities, must be paid in gold coin of the present weight and fineness. Or will the increasing scarcity of gold, and at least a temporary decline in wages and costs result in a silver-gold monetary basis? These are interesting questions to the political economist. It is the mining engineer's place only to point out that a decline in gold production is not the problem of the far-off generations—it looms big on our own horizon.

So far we have discussed chiefly the

[6] This too was helped by the recovery of hitherto lost gold and silver in electrolytic copper refining, which began to figure largely in the world's metal industry about 1890.

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losses due to the operations of peace. The losses of all of the metals have been multiplied many times by the Great War. The British high-explosive or shrapnel shell goes to the field with a brass head which is unscrewed, thrown away, and the time or percussion fuse screwed in. This fuse is also usually of brass, and the shell has a copper ring to take the lands of the rifling. The shell is fired, and the copper and brass are lost. If the shell is shrapnel, the lead-antimony bullets are lost also. The French shoot a rifle bullet which is pure copper, the other nations, one containing considerable lead and usually antimony, sometimes with a nickel-steel or cupro-nickel jacket. Every detonating cap used results in the volatilization of a little mercury. Early in the War it was estimated that 112,000 metric tons of copper were being consumed yearly by each side, much of it unrecoverable. The figure is probably low. The trench-furrowed fields of Europe will probably make rich picking for a while for the old-metal man, but most of this spent wealth will almost inevitably be lost and the close of the War will find a world even more impoverished than most economists believe.

The above are those metals which are commonly and erroneously expected to remain a permanent world's stock. Other mineral products there are which must be destroyed to be used. The anthracite fields of Pennsylvania are the one great supply of this fuel now known. Four authorities have worked on this problem separately, and their conclusions are concordant, at the present rate of mining, this century will see the end of the anthracite industry.

Petroleum has a useful history of little over half a century. In that time it has grown to a world's yearly production of about 300,000,000 barrels, with a sickening history of waste through burning oil wells, unstored surplus poured upon the ground, and insufficient provision against premature water logging of producing wells.

One can not say that petroleum production, even in the United States, has reached its maximum. Nevertheless it has been pointed out[6] that in the early days of the industry the average depth of well was 150 feet, ten years later is was 400 feet. At the beginning of this century it was 1100 feet, and today the average depth of oil may be placed at 2000 feet, a very considerable proportion of the earth's workable crust. M. L. Requa[7] puts the probable life of the flowing California wells at 29 years. That is, our children will face the necessity of all of this territory being replaced.

American natural gas is already far in its decline. Criminal—insanely criminal—is the only characterization of the former waste of this resource. Street lights burned all day because it was "cheaper" to let them burn than to shut them off. Towers of flame often advertised new oil fields, as it cost too much to market the gas. Factories and residences used it with a now almost unthinkable lavishness. The Middle West's glass makers and zinc smelters repent too late, in ashes—ashes of the once despised coal—Kansas and Oklahoma already struggle over interstate gas traffic, while I think in some degree the remarkable drop in the ground-water level of the Mississippi basin must be ascribed to the emptying of the billions of cubic feet of space once occupied by this gas.

[6] *Engineering*, Jan. 9, 1914.

[7] Bull. 85, Mining and Metallurgical Society of America.

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The question will of course arise, why will not the future give us as munificent ore supplies as have the past few centuries? Because the world is fairly well explored, the bold outstanding outcrops have been found; the future deposits will be those in depth, and incomparably more labor and material must be expended in their discovery, development, mining, and marketing.

The considerations of bituminous coal, lignite, and iron ore must be omitted. The resources of these most valuable of all minerals are still matters of centuries. The known deposits of the world are variously estimated at from 600 to 1200 years. Yet this is short compared with the known duration of metal-using man. There are, of these minerals, vast potentialities still unexplored and undeveloped. But again I say, mineral deposits do not grow by sensible increments. And in the meanwhile, every railroad rail, car wheel and brake shoe is wearing away, and wherever man sets his foot, iron is flaking off through insidious friction. And certainly we are not rich enough to throw away $40,000,000 in by-products of coke ovens, as the Government statistics say we did in 1914.

Aluminum has not been touched upon. Its deposits are vast, its metallurgy new. But in many ways it is undesirable. Acids and alkalis alike corrode it, its strength is small. The minor metals, nickel, cobalt, platinum and their forty or fifty brethren may be omitted because they are minor, and because the same story, or a worse, of waste might be told of each one.

As to the two feet of arable soil on which our existence rests, we treat that no more kindly. We clear away the natural covering of protecting herbage, a torrential rain comes, against which we have made no provision, and the slow work of a geologic epoch is swept away in one stormy night.

"There are parts of Asia Minor, of northern Africa, of Greece, and even of Alpine Europe, where the operation of causes set in action by man has brought the face of the earth to a desolation almost as complete as that of the moon; and though, within that brief space of time which we call 'the historical period,' they are known to have been covered with luxuriant woods, verdant pastures and fertile meadows, they are now too far deteriorated to be reclaimable by man, nor can they become again fitted for human use" (writes George P. Marsh in his book, "The Earth as Modified by Human Action.") "The Alps of Provence present a terrible aspect. In the more equable climate of northern France, one can form no conception of those parched mountain gorges, where not even a bush can be found to shelter a bird, where, at most, the wanderer sees in summer here and there a withered lavender, where all the springs are dried up, and where a dead silence, hardly broken by even the hum of an insect, prevails. But if a storm bursts forth masses of water suddenly shoot from the mountain heights into the shattered gulfs, waste without irrigating, deluge without refreshing the soil they overflow in their swift descent and leave it even more seared than it was from want of moisture.

"Man at last retires from the fearful desert, and I have the present season found not a living soul in districts where I remembered to have enjoyed hospitality thirty years ago. It is certain that the productive mould of the Alps, swept off by the increasing violence of that curse of the mountains, the torrents, is daily diminishing with fearful rapidity. All our Alps are wholly, or in large

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proportion, bared of wood. Their soil, scorched by the sun of Provence, cut up by the hoofs of sheep, which, not finding on the surface the grass they require for their sustenance, gnaw and scratch the ground in search of roots to satisfy their hunger, is periodically washed and carried off by melting snows and summer storms."

We usually do these works of destruction better than the French—our record with the three great typical American bare-ground crops of corn, cotton, and tobacco would need still more emphasis.

The two great indestructibles of our school days were matter and energy. They were the immortals. Perhaps, but there are at least degrees in energy. Lord Kelvin postulated that in every transfer or transformation of energy, a certain part was set free as thermal energy, and apparently looked forward to a universe in which all force had been uniformly distributed as thermal energy —a dead level, from which nothing could ever raise itself by its caloric boot straps—a universe all at one temperature.

Matter likewise has its degrees. Iron-ore deposits are valuable because they are comparatively pure. An earthy crust, neatly mixed, containing in every cubic centimeter the same percentage of silica, iron, gold, and tin as the present crust does in its more or less segregated deposits would be of little practical value. Toward such a final degradation of matter man's best efforts are tending.

The United States consumes about 16 pounds of copper per capita per annum; Africa and Asia a fraction of a pound. Can these people rise to our standard of use? Obviously not. Or shall we descend to theirs? God forbid. But what can we vaguely see? A substitution of ceramic products wherever metals can be replaced. A marvelous growth of the aluminum industry. An age of steel succeeding the few centuries of many metals, as of old, the age of iron followed the age of bronze. A closer attention to preventable metal wastes. A certain dignifying of the junk man. Wars for the possession of newly discovered or not yet exhausted mineral deposits to which only the present conflict will be comparable. (Indeed may not the present war be to confirm title to the iron ores of Lorraine and to secure at least a preëmption on the iron and coal resources of Belgium, together with those of Luxemburg and France?)

More immediately still, we should see under the stimulus of higher metal prices, better metallurgical recoveries. With copper at 25 cents per pound one can spend more on making a better extraction from the ore than with copper at 12 cents. A greater use of water and wind power. And, as stated above, in discrete form, a generally enhanced metal-quotation list, or what is the same, lower pay for labor, an enhanced value of present long term securities, and greater value for present ore deposits in case their life exceeds that of a generation of man.

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EDITORIAL COMMENT

WATER-POWER LAWS

SECRETARY LANE, in the report of the Department of the Interior, has advocated the opening of water powers now under Federal jurisdiction, but specifically advises that the operating companies be subject to State or Federal license. Mr. Darlington, elsewhere in this issue, believes that these water powers will be most advantageously developed by large public service corporations, and it is only reasonable to suppose that the greater benefit to the public will accrue through such development and through such a linking up of systems as he describes. The leases on such plants should be sufficiently long to justify the operating company in the heavy expenditures required; but, again, the lease should be so adjusted as not to extend an unreasonable period beyond the time when construction expenses had been offset. Mr. Darlington estimates those expenses at the rather low figure of $100 per horsepower, and the annual operating cost at $11.50. With such estimates, it would be comparatively simple for a commission to determine at what rate and through what period a reasonable return might be expected on the investment. Such predetermined rates and leases would effectually prevent any harmful exploitation; the operating company, anxious to renew its lease, would truly be a public service.

COMMON SENSE AND PREPAREDNESS

VARIOUS aeronautical associations and committees for defence have been greatly concerned during the past few months over the scant supply of aeroplanes actually in military service in this country. Dr. L. H. Baekeland, in a recent speech, effectually explained this shortage, and at the same time advanced a strong argument for the proposed experimental laboratory advocated by the Naval Consulting Board. He told how the German government had subsidized automobile engine makers and had developed a highly efficient aeroplane motor; that the Allies, dissatisfied with the performance of their motors, had finally succeeded in capturing a German machine which they reproduced faithfully in all parts only to find that, because of complicated alloys used in the German machine, their copy failed to give any better results than their former designs. His moral from this is convincing: It would be folly for this Government to expend millions on the purchase of machines which will not bear the test of active service until it shall have perfected motors that will give adequate service. Aeroplane manufacturers have not the funds with which to carry on such experiments. A Government laboratory, failing subsidized manufacturers to make the tests, would have a better chance for successful investigation.

JOHN ALEXANDER HILL

AT the hour of going to press we were informed of the sudden death of John Alexander Hill. Mr. Hill was widely known as the able and enterprising publisher of *American Machinist, Power, Engineering and Mining Journal, Engineering News,* and *Coal Age.* He will be long remembered in engineering circles.

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OUR DEVELOPMENT AND OUR POWER

SPIRIT AND RESOURCES OF THE UNITED STATES OF AMERICA

OF all the departments at Washington, that of the Interior is probably most intimately concerned with engineering matters and the recent report of Secretary Lane is conceived and executed in a manner to appeal to all engineering readers. It is truly a wonderful report, one that lays aside the old formalities and takes a form calculated to attract and enthrall even the casual reader. It reveals its author as having a breadth and depth of knowledge too often lacking in cabinet officers, and certainly no secretary ever wrote like this:

"In the development of this continent, the discovery of its resources and their highest utilization, there is a fascination to the American which is superlative. It is indeed our life, and has called out the most sterling qualities in our characters. Those foreigners who write of our country often engage in facetious if not scornful comment upon our bombastic manner of telling the story of our growth and of the things achieved or possessed. They fail unfortunately to see far enough into the secret of our pride. To have taken the prize for the largest pumpkin at the county fair, or to have milled more ore in a day than any other mine, or to have built the highest dam in the world—such things are to us adventures which make the game of opening a new country worth while.

"No one would smile when told that a foreign army had made an unprecedented number of miles in a day's march, or had brought into action a gun of unrivaled caliber, or built a ship of unequaled displacement or power. These are the very things on which nations pride themselves as revealing their capacity, ingenuity, or resourcefulness. They make for national self-respect and self-confidence. And so it is with the American. His place in the scheme of things is to reveal to the world what can be done in the development of a new country, and every crop raised, every schoolhouse built, every rail laid, every nail driven is evidence that the work he is sent to do is being done. Instead of being the petty boasting of a parochial-minded provincial, this spirit is of the very essence of the highest creative quality.

"It is not a figure of speech to say that every American has it in his heart that he is in a small sense a discoverer; that he is joining in the revelation to the world of something that it was not before aware of and of which it may some day make use. Men work for what they think worth while, and if they find their joy in proving that land has coal, or will raise wheat, or that a refractory ore may be reduced at a practicable cost, and tell about it proudly, they may be serving themselves, but they are also serving the world. The clerk in

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the store or the mechanic in a mill may not consciously engage in any enterprise which makes this appeal, but when he learns that the Government of which he is a part has within the year opened a town on the shores on the North Pacific which now has nearly 3,000 inhabitants, and has driven a railroad nearly 40 miles inland toward the Arctic Circle on its way to the coal fields of the Matanuska and the gold fields of the Tanana, he has a feeling that he, too, is participating in the making of this new world. One might say that this was nothing more than sentimental pride. There is a truer and more dignified word for this quality; it is the expression of the American instinct for improvement. We have a passion for going into the unknown, for answering the puzzles that are put to us. Our imagination is challenged by difficulty. And the result has been a century of growth, which in its magic and its largeness casts a spell upon the mind. . . .

"With the exception of one or two minor minerals, the United States produces every mineral that is needed in industry, and this can be said of no other country. We produce 66 per cent of the world's output of petroleum; 60 per cent of its copper, 40 per cent of its coal and iron, and 32 per cent of its lead and zinc. Tin in small quantities is produced in Alaska and platinum in Oregon, Nevada and California; manganese in Virginia, Georgia, Arkansas and California; but of these latter minerals, as of nickel and some others of less importance, our supply is altogether inadequate for our consumption. We can build a battleship, or an automobile (excepting the tires), a railroad or a factory, entirely from the products of American mines or forests. To replenish the soil we have phosphorus in abundance, potash is known to exist in the deposits of Searles Lake, California, which, however, is not yet commercially available, and in alunite where it is combined with aluminum and deposits of which are found in several states; and nitrogen can be extracted from the air by cheap hydro-electric power as is now done in Germany, Norway and elsewhere. So that we can feed the earth and keep it sustained. Our soil and climate are so varied that we can produce all the grains, fruits, vegetables and fibers known to the Temperate Zone, and some found in the semi-tropics. And to crown all these we have water power that can be made to generate perhaps as much as 60,000,000 horsepower."

Secretary Lane then discusses our reserves in the public domain, which now lies chiefly in Alaska, our deposits of fuels and fertilizers still owned by the Government, the mineral possibilities of Alaska, the future development of dry farming and irrigation, our small army of school children, and has this to say of our inventors:

"During the past 50 years the people of the United States have uttered two-thirds of all the revolutionary epoch-making inventions of the world, ranging from the telephone and the incandescent lamp to Wright's aeroplane and high-speed steel. Each day we issue an average of 200 letters patent to American inventors, and the number of inventions is increasing with the years."

Our wealth he sums up as follows: "These, then, are the assets of the United States as revealed in but this one department—lands and waters and mines, inventors and chemists and engineers, and a new generation coming on which shall add still farther to the adventurous annals of peace."

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Speaking in a somewhat similar vein, George Otis Smith delivered a striking address before the Pan-American Scientific Congress in Washington recently. While the theme of his speech was the necessity for wise control of mineral production, his exposition of the basic importance of the mineral industry and its rapid development in this country is worthy of quotation:

"A nation's store of mineral deposits is a national asset whose value can not be easily overestimated. . . The higher the stage of civilization a nation may attain the more exact becomes this conception that mineral wealth is the foundation of power. . . Independence through possession of the material resources essential to modern life is itself a promise of a nation's integrity, and the nation that makes the whole world its debtor through shipments of the mineral fuels and the metals and the mineral fertilizers occupies a strategic position in the construction of international policy. . .

"It is as ths basis of a nation's industrial growth, however, that mineral resources loom largest. Both self-centered independence and world-wide participation in commerce must come through the fullest use of these basal materials. Consumption of the essential minerals does not place a nation in the spendthrift class, but is in fact a measure of its industrial efficiency. . .

"In any discussion of the national significance of the advances in engineering it is important to realize that the object of the engineering sciences is simply to win the largest results with the least possible expenditure of labor. If a poet ever seeks a theme in the story of the mines he should write the epic of this struggle of man with mountain masses, where victory comes only through the harnessing of Titan power. Today huge steam shovels mine iron and copper and coal and giant electric dredges win the gold from gravels that are too poor to work by less efficient methods.

"Thus it follows that the most gratifying phase of this mining development is the marked increase in man's productive capacity. Let us take the 20-year period 1889-1909 and analyze the coal mining record. Roughly stated, the number of mine workers has a little more than doubled in that period, the output of coal has more than trebled, and the capital investment has more nearly quadrupled. . . Stated in terms of efficiency, the mine worker increased his individual output from 471 to 691 tons a year, while the annual average output per dollar of capital remained nearly the same, about two-fifths of a ton. . .

"In iron mining the record for the same period is even more striking; the number of miners increased less than one-half, the capitalization nearly trebled, and the output nearly quadrupled. . . All this tells the story of steadily increasing efficiency of mine worker, mine equipment, and mining methods that is, of the contributions by labor, capital and engineering. . .

"The human aspect of this picture of change in the mining industry is full of encouragement to everyone interested in the welfare of his fellow citizens. That type of industry is most to be desired which employs a maximum of skilled labor and a minmum of 'muckers.' The labor of any country is most benefited by the export of finished products rather than of crude ore and by the import of raw materials rather than of manufactures."

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How Advertising Promotes Efficiency

Wide Publicity Stimulates Invention and Operating Economies

RARELY is the powerful position of advertising in our modern industrial organization better described than in a paper by A. R. Maujer recently delivered before the Ohio Society of Mechanical, Electrical and Steam Engineers. Mr. Maujer writes with the wide horizon of both the engineer and the advertising man. Portions of his address follow:

"There is a fond old saying that necessity is the mother of invention. This is anything but the truth. Think for a moment. Did necessity invent the railroad, the steamboat, the sewing machine, the telegraph or the air-brake? You are hardly justified in saying, yes, when you remember the positive unpopularity which some of these inventions caused their authors, and the incredulity and indifference with which the balance were received. . . . It is recorded that when Howe first exhibited his sewing-machine in Boston, the public, far from recognizing it as a heaven-sent offspring of necessity, smashed it to pieces. Morse spent many years in fruitless pleading before he obtained financial and public assistance and encouragement with the telegraph. Westinghouse was branded as a fool by railroad experts when he brought out his first airbrake.

"The trouble in each of these cases was that the demand, the necessity for the invention was lacking. . . . So we would be nearer the truth if we said 'Invention is the mother of necessity.' . . . It is no wonder then, that inventors and manufacturers, in the times when the spreading of knowledge and information was difficult and slow, found themselves all but thwarted by the indifference and even opposition of the public.

"Modern advertising is increasing the rapidity with which progress in engineering is being made. It is constantly raising the general level of efficiency in all branches of engineering. It does these two things by eliminating time. Information which once took months and years to spread thinly can now be spread thickly almost over night.

"When a man or a company develops a new, more efficient and more reliable or better boiler, engine, dynamo, motor or what-not, all the engineering magazines are more than willing to give it full attention in the editorial section. Scientific societies welcome illustrative papers upon it for their journals and for discussion.

"Advertising serves to raise efficiency in engineering by constantly reminding us of new and more efficient machines and methods. A man gets up a new flow meter, an automatic coal weigher or some other economy device. Through his advertising he tells a hundred thousand engineers about it and inspires a thousand to make installations. Through advertising he has raised the general level of engineering efficiency by a thousand improvements in equipment. He casts about and finds new uses for his device and new arguments as to why it should be installed. Through the megaphone of advertising he impresses these upon the engineering public again and again. In this way he prompts the installation of another thousand, two thousand or ten thousand installations. He has raised the level of efficiency by just that number of installations."

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BETTINGTON BOILER FOR PULVERIZED FUEL

PROBLEM OF STEAM GENERATION WITH POWDERED COAL APPARENTLY SOLVED

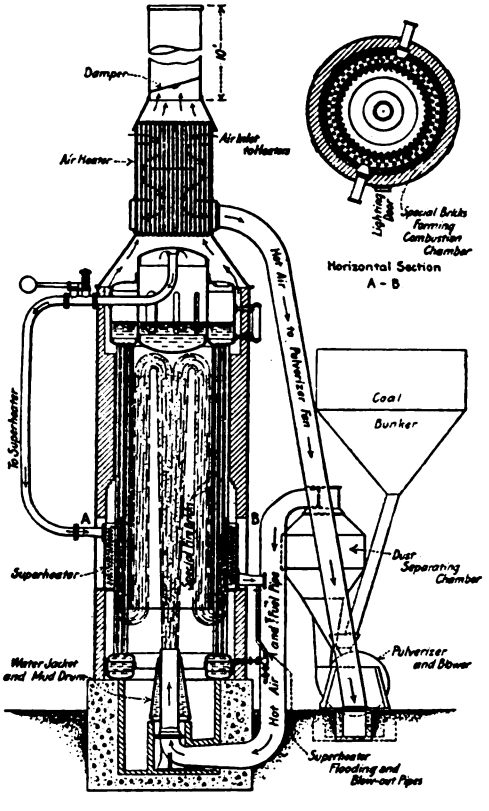
AT the close of Technical Paper 123 of the Bureau of Mines, on the use of low-grade fuels in Europe, the author, R. H. Fernald, gives a brief description of the Bettington boiler, an English boiler designed to burn powdered coal. The use of pulverized fuel in metallurgy, and for steam generation both on locomotives and in stationary boilers, is a conservation measure of the greatest importance. Considerable interest therefore attaches to this description.

A sectional elevation of the boiler is shown in the illustration. Its operation is described thus: "The fuel passes from the coal bunker to the pulverizer. It is then picked up by the blower and carried into the furnace through the air and fuel pipe by a jet of preheated air. On its way to the furnace the fuel is passed through a separator, which removes particles of fuel which are not sufficiently pulverized to meet the successful operating requirements of the plant. The fuel is injected vertically upward, the blast pressure being regulated to prevent the impinging of the flame on the surface of the upper drums.

"The vertical inner tubes are surrounded by brickwork with the exception of the lower ends, so that the gases of excessively high temperature and the impinging flame are practically confined in a brick-lined combustion chamber.

"The molten ash and slag collect in the ash receiver below the boiler."

Among the difficulties encountered in burning pulverized coal, the following are enumerated: Maintenance of continuous ignition; destructive effect of temperatures; production of continuously homogeneous mixture from varying coals; maintenance of air and fuel mixture without segregation; handling of molten ash.



BOILER FOR POWDERED COAL

The author comments on the excellent performance of the pulverizer employed at the installation visited and on the method of enclosing the watertubes in what is practically water-cooled brick.

As to performance, the boiler examined had slightly over 2,600 square feet of heating surface and an evaporative capacity of 14,000 to 22,000 pounds of water per hour; the power for pulverizing and feeding the fuel was about 3 per cent of the boiler capacity.

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BOILER CORROSION PREVENTED

COMPOUND SUCCESSFUL WITH ANY WATER FOR ANY LENGTH OF TIME

A METHOD of preventing boiler corrosion and scale formation, so simple, economical and effective as to be deserving of the widest publicity, is described by Allen H. Babcock in a paper presented before the American Society of Mechanical Engineers.

Mr. Babcock notes that the method which he describes was brought to his attention by an article in the August, 1912, *Journal* of the American Society of Naval Engineers, written by Lieutenant-Commander Frank Lyon. Commander Lyon recommended a compound which, according to Mr. Babcock, "is composed of sodium carbonate, tri-sodium phosphate, starch and tannic acid. The sodium carbonate takes care of any chemical reactions and renders the solution non-corrosive. The tannic acid and starch are added to prevent the formation of scale, the action being to hold the impurities in suspension in a colloidal state. The trisodium phosphate prevents the rise of the surface tension of the solution and consequent priming caused by the impurities in the water and by the application of the other ingredients in the compound. In using the compound to prevent corrosion a sufficient quantity must be added to each boiler to render the alkaline strength of the water in the boiler 3 per cent of normal or above.

"The compound may be purchased from the Government Contractor for about one-half the cost of the ordinary compounds."

Mr. Babcock had been having endless trouble with the twelve 645-horsepower water-tube boilers of the Fruitvale generating station of the Southern Pacific Company and had tried almost every device in an effort to cut down the excessive number of tube renewals. He determined to try the Navy compound. As a result, tube renewals, which had been running at the rate of about 1400 a year, were cut down to practically none. In addition the money saving in repairs and maintenance was over 90 per cent. "The treatment as practiced there costs about $80 a month, depending upon the amount of compound used. There is no scale in the boilers; they are absolutely clean. Below the water line they show clean black iron; above, a thin coating like whitewash."

This success led the Southern Pacific to try the compound on some of its Mallet locomotives in Southern California which had to operate with especially poor feed water. Its success there was equally marked. Finally as evidence of the wide application of the method, Mr. Babcock instances the Associated Pipe Line Company, operating a string of steam pumping stations between the San Joaquin Valley and San Francisco and using about every known grade of boiler water. This company found the compound effective in every one of its 30 plants.

Mr. Babcock emphasizes the universal applicability of the compound. "The method . . . applies one corrective to all waters. A different composition of feed water demands not so much a different composition of corrective as a different quantity thereof. . . . The only requirement is that the boilers must be treated individually."

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STEAMBOAT, FLOATING BRIDGE, OR BARGE?

LIGHT SELF-PROPELLED BARGES OFFER ADVANTAGES OVER OLD-STYLE STERN-WHEELERS AND SUPERFLUOUSLY HEAVY BRIDGE-COMPANY DESIGNS

POSSIBILITIES of development of our interior waterways as an auxiliary to the railroads and as a check, have long been earnestly discussed. Arguments for and against have been printed without number and the question is still undecided; it would appear, however, that increased efficiency in methods of water transportation might turn the scales in favor of increased waterways development. Interest therefore attaches to a paper presented by J. H. Bernhard before the Society of Naval Architects and Marine Engineers, in which he describes his success in building and operating light self-propelled barges on our Central rivers.

The author first chides the members of the society addressed because their profession has paid so little attention to the design of craft for navigating narrow, inland channels. "They have left these problems to laymen, with the result that, while it may be ridiculous for an investor, if he wanted to build a trolley line, to go to an old-time conductor or street-car motorman and take his advice how to build such a line merely because such man was twenty or thirty years in such service, it is apparently not ridiculous for the investor to go to a captain or pilot and ask him how to build a river boat, providing these captains or pilots can show many years of service."

Deficiencies in the old-time style of stern-wheel river boat lead Mr. Bernhard to wax eloquent:

"First of all you are bound to see the great handicaps that are imposed in the nature of the structure of such vessels to economical loading and unloading. The decks of these steamers could very favorably be compared with young forests instead of steamer decks.

"An important feature of the old-time river steamers seems to be the amount of smoke they can discharge from their funnels. The more smoke the more pleased is the captain.

"Another very important part of successful or unsuccessful navigation, depending upon from what angle you look at it, is the whistle. When I sailed a modern self-propelled barge . . . up the Mississippi on a round trip of 4,000 miles, and carried the freight profitably at half the cost of transportation on other steamers, I was severely criticized for putting such a craft upon the river because its whistle could not be heard for several miles.

"Finally one of the best prevailing rules of measuring a successful steamer is by the amount and height of waves it creates. I had to face severe ridicule because this poor boat of mine could carry 1,000 tons of freight at full speed without creating enough waves to rock a row-boat."

Mr. Bernhard is equally severe upon the designers of steel barges who have attempted to supplant the old stern-wheeler. "Bridge-building companies went into steel barge construction and apparently are holding their own without doing really anything else but building bridges around which they build a watertight hull. In this connection some really amusing facts could be given. For instance, one official of such a company did not want to build a barge for me on my design because he could not see how such a barge, not being

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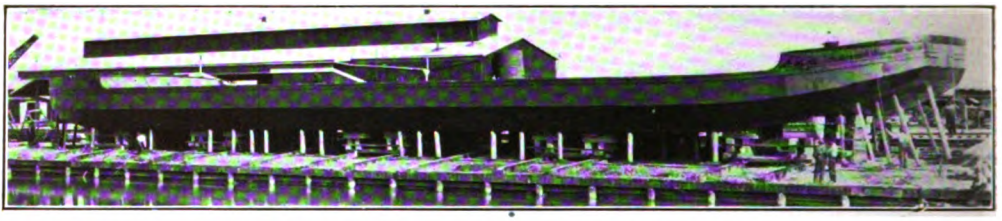
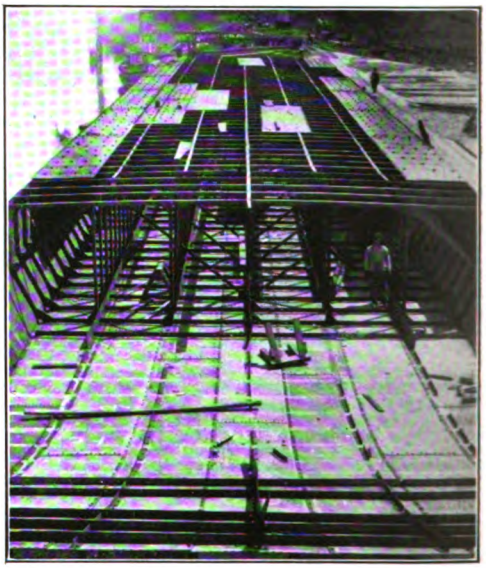
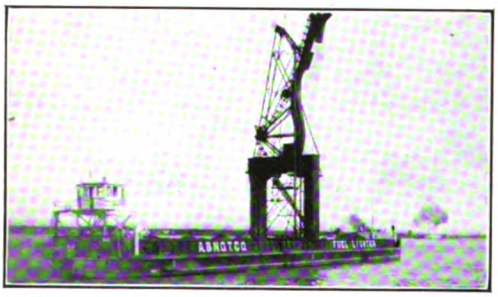


Showing hull of barge ready for launching

Typical old-style steamboat with decks like "young forests"



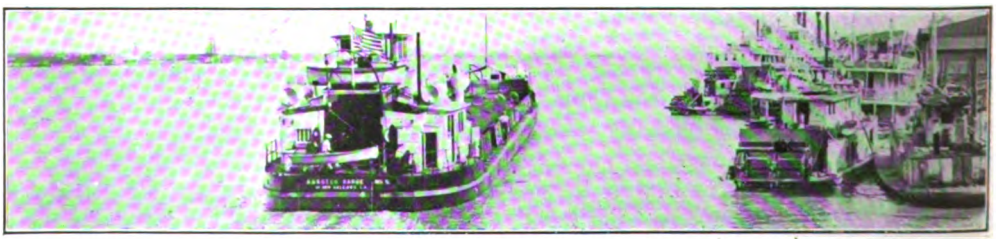
System of construction of barge hull; light framing and plates



Self-propelled fuel lighter showing elevator construction carried

Barge fully loaded

Barge running light



Contrast between barge and steamboats

MODERN BARGES AND THEIR ANCIENT COMPETITORS

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strong enough to be loaded at one corner with the other corner sticking out in the air, would do, and the very fact that the barges I would build had to be loaded and unloaded with the same care that one would use when loading ocean vessels was proof in this man's eyes that the barge was undesirable."

A graphic description of the route for which Mr. Bernhard built his first successful barge is as follows: "This was from New Orleans to Tuscaloosa, Alabama. First from the Mississippi (at New Orleans), where the very strength of the river accumulates to its maximum, the craft had to enter, through a lock only 40 feet wide, a shallow canal, its entrance diagonal upon the fast Mississippi. This canal was the Lake Borgne Canal, crooked as the Lord of Lower Regions, shallow as a pool, and sufficiently narrow to tempt you to jump across it." The route thereafter followed Mississippi Sound, Mobile Bay open to Gulf waves, the Alabama, Tombigbee, Warrior and Black Warrior Rivers, presenting varied kinds and degrees of difficulties.

The first trip was a success and brought confusion on a host of critics. "These boats have been plying ever since, carrying freight over this route, a distance of 1,050 miles, and returning empty, at a total cost of 40 cents per ton, or about ⅜ mill per ton-mile, one-tenth of the average railroad charge."

The barges had the cargo on the deck; no hatches were cut, the deck being airtight and watertight like the bottom; watertight bulkheads were provided. "By placing the cargo on the deck, I had the advantage of having the entire hold available for strengthening purposes, so that I could place the steel where it would do the most good and have as much as possible the steel members under compression, letting the hydraulic pressure counterbalance the load pressure. The result was that I could use very light material, the hull being built out of ¼-inch plate and frames out of 2½ by 2½ by ¼-inch angle iron. The further result was that the barge, although she carried 1,000 tons net, had only 170 tons of steel in her, and, together with the machinery, bunkers and the like, a total of 240 tons. These barges displaced 1,240 tons of water, were given a speed of 8 miles per hour with only 150 horse-power, using for this purpose gas-producer engines burning breeze coke, which brought the cost down to 1-10 cent per horse-power per hour."

Based on this experience Mr. Bernhard is now building a number of barges for the Inland Navigation Company, to be of two classes, high-speed and low-speed. The former will be 310 feet long, 56 feet wide, with a 7-foot draft, designed to attain a speed of 20 miles in slack water; the propelling engines will be four in number, each of 600 horse-power. The slower type will be 240 feet long and 42 feet wide, to carry 1500 tons on a 7-foot draft and 500 tons on a 3½-foot draft. This type will be propelled by four Fairbanks-Morse, oil engines, each of 80 horse-power. Electric current is to be generated for lighting, heating, cooking, steering, pumping, refrigerating and hoisting.

Mr. Bernhard seems to have hit the nail on the head and to have hit it hard in the following paragraph:

"I believe that navigation upon our rivers is dead because, to some extent, of the fact that you naval architects and marine engineers have permitted the mechanical engineers to steal a march on you by improving their locomotives while you have been blind to one of the largest fields in the entire country for your endeavors—that of our inland waters."

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STEEL FOR THE NORTHWEST

PRODUCTION BEGUN IN NEW DULUTH PLANT OF STEEL CORPORATION

IRON and steel production depends for its geographical distribution on a variety of factors, of which the most important hitherto have been freight rates on ore and on coal or coke and markets for the manufactured products. Lately, it has been suggested that the possibility of using the byproduct gases for public-utility purposes would exert an increased pull toward the largest centers of population. The resultant of the various factors noted have operated to center the industry in the Ohio Valley and the vicinity of Chicago. Despite the predominance of the Lake Superior region as a source of iron ore, there have been no steel works built in or near that region and only some minor iron furnaces until the Steel Corporation some years ago decided to put in a complete and extensive plant at Duluth.

This new plant produced its first steel on December 13 of last year. Commenting on the plan for establishing this plant some time ago, *The Iron Age* had this to say:

"Farming, the chief industry of the Northwest, does not require much steel in the direct-from-mill forms. Iron and steel manufacture is in its infancy west and north of Duluth, but a recent readjustment of freight rates favorable to Duluth has enlarged the market to the south and southeast very materially. But for the present at least the railroads will undoubtedly take the largest part of the tonnage produced. As a railroad center Duluth has made rapid strides in the last few years. . . . With steel available on a competitive basis and the general labor market improved, the advent of many forms of manufacture may be confidently expected.

"The location of the plant as affecting the cost of assembling raw materials appears to give it a considerable net advantage. Limestone will be secured from Michigan, near Alpena, the development of which deposits will also supply the Chicago plants. Here Duluth will have a longer water haul against the haul to Chicago. Rail freights on coal from West Virginia to Chicago are more than the rail and lake rates to Duluth. On ore the Duluth plant will undoubtedly enjoy a special rail rate from the mine, an allowance being made for the elimination of the handling on the vessel loading docks. Ore also will be shipped continuously through the winter from the underground mines to the plant and it will not be necessary to carry any more ore at the furnaces than the stock bins will accommodate. On the other hand it will be necessary to secure the entire year's supply of coal and stone during navigation."

In a recent issue *The Iron Age* summarizes the equipment of the plant:

"Briefly, the plant comprises coke ovens with a daily capacity of 1,000 tons; a by-product recovery plant; two blast furnaces rated at 500 tons each; a gas-engine-driven blower and electric generating station; an open-hearth plant providing for ten 75-ton furnaces, of which seven are completed; a combination rail, structural, billet and bar mill, and a merchant mill. The entire works have an estimated annual capacity of 350,000 tons of semi-finished and finished steel products."

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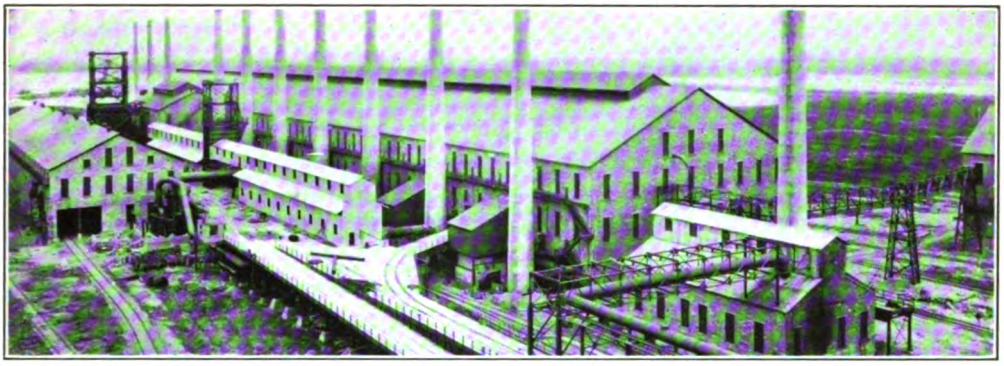
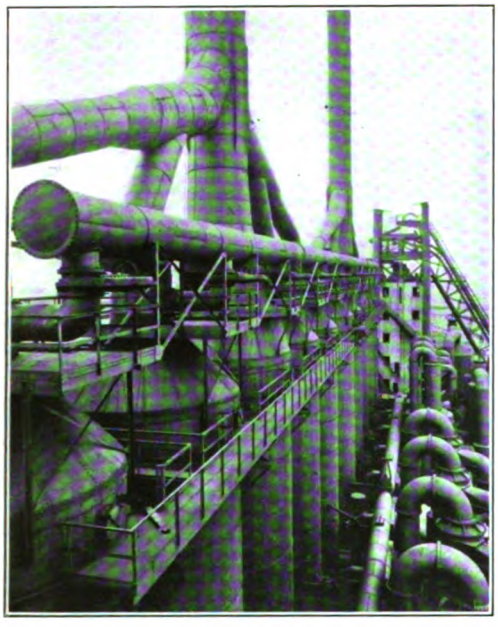
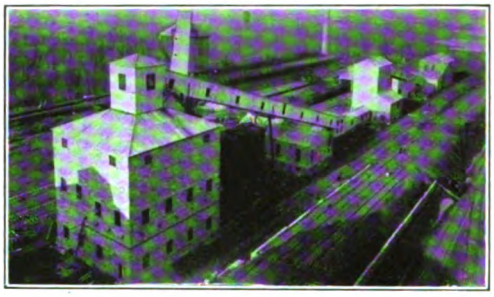


MINNESOTA STEEL COMPANY'S OPEN-HEARTH BUILDING

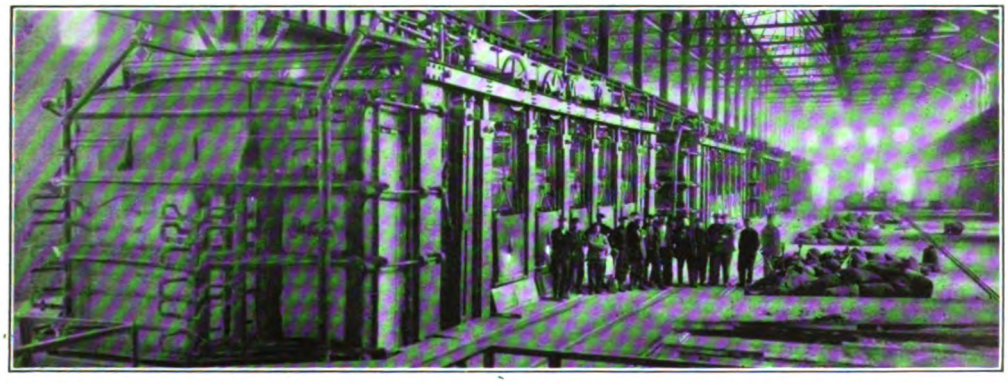


TOP OF STOVES



COAL HANDLING AND COKE PLANT

GAS-DRIVEN BLOWING ENGINES



CHARGING SIDE OF OPEN-HEARTH FURNACES

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How Billiard Balls Are Made

ELEMENTARY METHODS FOR A HIGHLY ACCURATE PRODUCT

IT is always interesting to learn the process of manufacture of some article or material with which we are familiar. This is the case with ivory billiard balls, the making of which is described by Edward K. Hammond in *Machinery*. In these days of automatic machinery, the methods followed in turning these balls from the rough ivory seem almost primitive. The set of tools is extremely simple and the perfection of the finished ball is the result of long experience and skill on the part of the workman.

The variety of ivory known as "soft" is preferred for the work, since it is more easily worked and is less likely to crack in service from impact or from changes in climate. The material comes to the turner in short cylinders, sections of the tusk, and since it is worth $4.50 a pound, considerable ingenuity is necessary in preventing waste; economy requires the making of six or eight rings as a byproduct from a block yielding a single ball; these rings are used on harness and for similar purposes.

"The lathes on which the turning is done are fitted with wooden chucks which are made of either dog-wood or beech-wood. . . . The form of chuck used for the first operation has a conical-shaped gripping surface, and the ivory block is first ground down on one end on a disk wheel so that it can be driven into the chuck by striking it with the hammer handle."

After setting up the work, the turner takes off a roughing cut with the gouge *A* and then with the tool *B* works in at the end and from the sides so as to outline the rings *C*, *D* and *E*. After taking off the rings *C* and *D*, he works out the hemispherical end and finally gets the ring *E*. Half of the rough ball has now been formed, and the piece is removed from the chuck, set up in the reverse position in another chuck of different form and the other half of the ball similarly roughed out with the production of three more rings.

With the ball still in this second chuck, the tool *F* is used for truing up. "After half the surface of the ball has been turned in this way, a sharp lead pencil point is applied to the revolving ball to draw a line around it." Using this line as a guide, the operation is repeated on the other half of the ball. Then the ball is again removed and set up on another axis so that "while the axis of the lathe spindle was formerly perpendicular to the plane of the lead pencil circle . . . it now lies in the plane of this circle." The truing operation is now repeated, which practically completes the actual turning.

"The ball is tested for accuracy by applying a very sharp lead pencil point, so that it just touches the surface of the work and noting whether a uniform line is left as the ball rotates. . . . If uniform lines are drawn in two positions of the ball at right angles to each other, it shows that there is only a negligible amount of error in sphericity."

For polishing, the ball is set up in a similar way in another lathe, the tool marks removed with a fine grade of sandpaper, and the sandpaper scratches taken out with a polishing cake. The final polish is obtained by rubbing the rotating ball with a cloth saturated in alcohol. The turning of the rings is accomplished in other wooden chucks.

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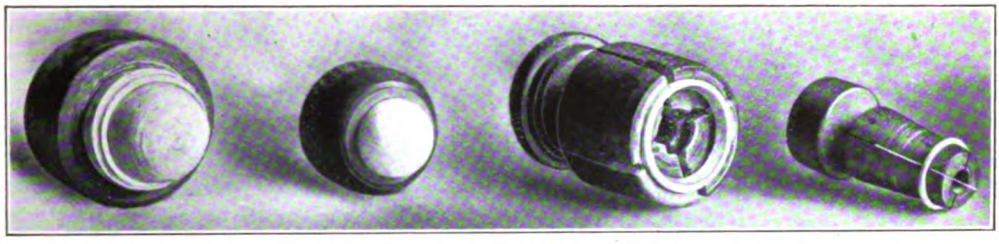
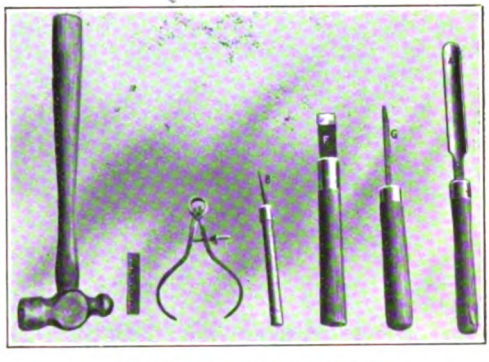
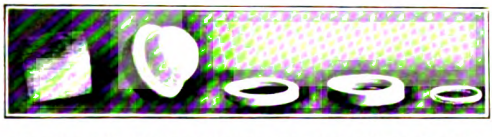


IVORY BILLIARD BALLS AND IVORY RINGS IN VARIOUS TYPES OF CHUCKS

FINAL TURNING OPERATION

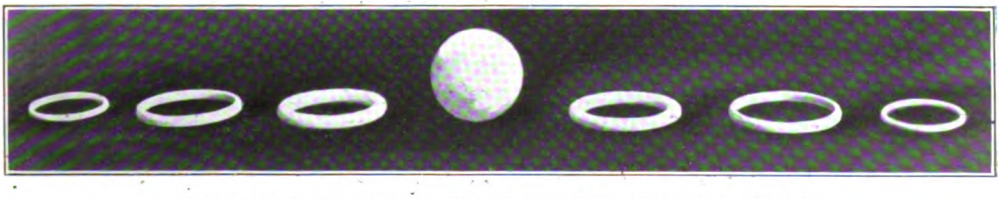


COMPLETE SET OF TOOLS



FROM LEFT TO RIGHT; NATURAL IVORY BLOCK; BALL HALF ROUGHED OUT; THREE ROUGH RINGS OBTAINED FROM FIRST HALF OF BLOCK

ROUGHING OUT THE BALL



FINISHED BALL AND SIX FINISHED RINGS FROM ONE BLOCK

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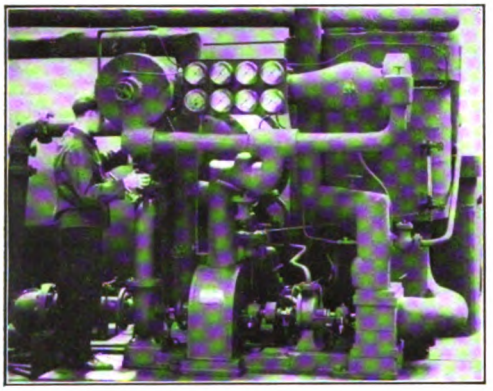
NEW REFRIGERATING MACHINE

WESTINGHOUSE-LEBLANC APPARATUS USING WATER FOR COOLING MEDIUM



COMPLETE REFRIGERATING UNIT

DESIGNED especially for shipboard, the Westinghouse-Leblanc refrigerating machine, just put on the market, embodies some old principles in new form and offers several distinct advantages over older types. Water is used for the cooling medium and is brought to the desired low temperature by evaporation into a vacuum. Attempts to use water thus have heretofore failed through inability to maintain a vacuum sufficiently low. In the machine under discussion, the Leblanc air pump is applied to maintaining the necessary vacuum and the whole scheme of operations hinges on the efficiency of this pump.

It is well known that evaporation of water requires heat and if no other heat is available, this will be drawn from the water which remains, thus cooling it. The cooling effect is greatly increased by accelerating the evaporation, and the evaporation can be accelerated by decreasing the vapor tension, as when a vacuum is established.

Working on this principle, the complete new machine consists of a condensing plant, a steam ejector, an evaporator, a brine pump and an air pump. The water to be cooled and used for circulating, is sprayed into the evaporator, where the desired vacuum is maintained. Part of it is evaporated and the remainder, lowered to the required temperature, is pumped through pipes to wherever the cold is to be used. The steam ejector sucks the water vapor from the evaporator and discharges steam and vapor to the condenser. The Leblanc air pump used works on a novel principle; a rotating impeller cuts off slices from an inflowing stream of water and projects these slices as pistons into a tangential cone. The pistons imprison successive layers of air and thus exhaust the contents of the condenser. A circulating pump handles the condenser cooling water and part of this water is used to keep cool the water from which the air-pump water-pistons are formed; this water would otherwise become too hot on account of the condensed steam.

The apparatus involves either a surface or a jet condenser, depending on circumstances; the details of operation differ, but the principles are the same. The cooling medium may be fresh water, when ice-making is not required, or brine, when low temperatures are necessary; in the latter case, two ejectors are used. The high and low temperature apparatus may be combined into one unit.

The advantages claimed for the system are the elimination of dangerous and often unobtainable gases such as ammonia, carbon dioxide or sulphur dioxide; a saving of weight and space; simple operation; low maintenance; and good efficiency.

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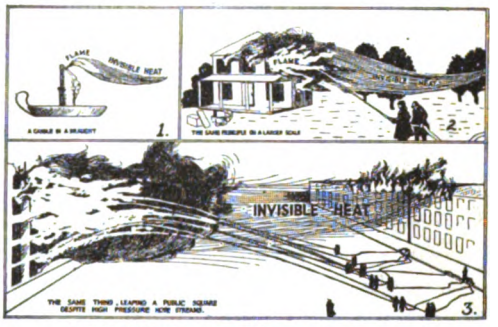
CONTROLLING THE "HOT BLAST" IN CITY FIRES

SHUTTERS AND SPRAYS EFFECTIVE WHEN FIRE DEPARTMENT IS HELPLESS

IN a recent address before the American Water Works Association, Albert Blauvelt set forth a highly interesting analysis of the conditions attending great conflagrations and outlined a method to check or prevent the spreading of fires in the more valuable parts of our large cities.

"At the time of diastrous fires," says Mr. Blauvelt, "the unfortunate practical fact is that such a fire is usually so large that it becomes a dry fire, one which does not receive any water at its heart or core. . . . Another unfortunate fact is that the bigger a fire, the more certain it is to be a fire which may be termed a dry fire." It follows that fire departments and water systems are of little use to stop such a fire from its path. All or most of the great city conflagrations in this country were of this type and swept on in each case until they reached a body of water.

Mr. Blauvelt goes on to explain the nature of the "hot blast" and the reason that fires are "dry." "The principle is a simple one. Let anyone hold the hand over the flame of a candle. You will find that the heat is not bearable to the hand even at a considerable distance when held directly over the flame. It is also noticeable that there is a strong upward draft although the air in the room may be quiet. In any fire the expansion of the gases due to the combustion speeds up the draft and we can calculate the velocity of the draft of a large fire from the manner in which it is able to throw firebrands. In a rough way it is a fair statement that the acceleration of draft local to, and immediately proceeding from, a fire is about four to one. That is to say, a 10-mile breeze fanning a fire is accelerated into a 40-mile wind as it issues from that fire. . . . It does not take a very large fire to produce a dangerous hot blast and if the wind is sufficient to carry this hot blast over into a fairly horizontal position, the firemen are then held at a distance and cannot endure the hot blast and must retreat. The rear or trail of a fire is



FORMATION OF THE HOT BLAST

necessarily a bed or trail of burning embers. The fire department cannot work on the front or rear of a great fire simply because the hot blast occupies the front and an area of burning ruins occupies the rear." These relations are excellently brought out in the drawing.

Mr. Blauvelt's remedy, is to establish inner fire limits inside the ordinary fire limits of great cities, so as to cover the most valuable property and act as a dam to the spread of a fire originating outside. The features of this inner zone would be thoroughly shuttered windows on alleys and well-supplied sprinklers inside the buildings. Experience has shown that the dreaded hot blast is checked or destroyed by such barriers so as to give a fire department opportunity for successful attack.

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ANOTHER ENGINEER'S LIFE

MARCUS DALY, THE ANACONDA AND H. H. ROGERS

FEW names stand higher on the roll of American mining engineers than that of D. W. Brunton. Eminent as engineer, geologist and operator, he is most widely known and also loved as the inventor of what is, all things considered, the best surveying instrument made, the Brunton Pocket Transit. In a recent issue of the *Mining and Scientific Press* Mr. Brunton reviews some of the incidents of his long life, which touched again and again on the great events in American mining history. Most interesting of all is the intimate account he gives bearing on his connection with the Anaconda Copper Company, part of which we quote:

"In his younger days [Marcus] Daly had been a working miner on the Comstock. When Butte was discovered he came there and secured the ownership of a number of the most prominent mines, which he organized into a company named after the principal mine in the group, The Anaconda Gold & Silver Mining & Milling Co., which name is still in gilt letters on one of the safes in the Anaconda Copper company's office in Butte. Daly . . . decided to prepare for future contingencies by engaging Mr. Scallon as attorney and myself as consulting engineer to his mines. . . . So rapidly did he push his various purchases and enterprises that I suggested to him one day that, owing to the irregularity of the orebodies and the difficulties of following them, we ought to have a competent geologist who would make a thorough study of the underground conditions, which was something I had not been able to find time for. His reply was simple, 'Jist remember there are no strings on ye.' As a result of this interview I began looking about for a suitable economic geologist and selected for this position Horace V. Winchell, under whose careful work and painstaking studies the mystery of the irregularities in the ore deposits was gradually unraveled. The geological department grew steadily in size and importance until it is now the most thoroughly organized and has the finest equipment of geological maps and sections of any mines in the world. . . .

"One day Mr. Daly said that the superintendents were all hounding him for more compressed air and that he had already bought more air-compressors than he had ever seen or heard of, and that he would like to know exactly how much more compressor-capacity was needed. . . . A careful study of conditions showed that compressed air was being used for many things besides the operation of drills, such as running pumps, underground hoists, and ventilating. In addition to this, when the stopes on a level were worked out, the pipes, instead of being taken down, were allowed to remain in place and sometimes not even shut off from the main line. . . . In addition to this the chain-gangs were exceedingly lax in tightening up leaks, a careful calculation having shown that if unnecessary waste could be prevented the mines already had more compressor-capacity than was needed. When I reported this to Daly he seemed incredulous. As the next day was 'Change Sunday' I asked him to come up to the Neversweat mine, where the principal compressors were situated, at 11 a. m. Of course, no drilling or

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underground hoisting was going on on 'Change Sunday,' and the superintendent and foreman were given orders to shut off all the pumps and ventilating pipes so that there would be no useful consumption of air. As the compressor-engines were fitted with indicators, it was easy to ascertain exactly the power necessary to maintain a constant pressure, or in other words, to offset the leakage. When Daly came up to the mine and the engineers explained to him that it was taking 1,100 hp. to keep up the leakage on the various pipe-lines his comments on the situation were amusing, strictly to the point, but hardly fit for publication. Next morning the chain-gangs were busy stopping leaks and the dealers in air-compressing machinery were a sadly disappointed lot. . . .

"Later, when Mr. Daly's health commenced to fail, the mines were sold to the newly organized Amalgamated Copper Company. Scallon and I were transferred with the property. H. H. Rogers, the virtual head of the Standard Oil Co., also assumed complete control of the Amalgamated Copper Co., and insisted on extending my jurisdiction to include the smelters. . . . After most careful consideration, I decided to offer the position [of metallurgist] to E. P. Mathewson, who was at that time in charge of the American Smelting & Refining Co.'s smelting operations in South America. The selection proved to be a most happy one for all concerned, as Mr. Mathewson's metallurgical skill, business ability, and unfailing tact have made the new smelting-plant at Anaconda not only a wonderful success, but the Mecca for copper metallurgists from all over the world. . . .

"Owing to the time required to make the trip from New York to Butte, Mr. Rogers was rarely able to visit the mines, but his memory and powers of visualization were so great that he had before him constantly a mental picture of what was going on in the West. Officials coming into his office from the mines and smelters were astonished to find him asking the most searching questions in the most familiar way about everything that was going on, as if he had only visited the property a few days before. Again, the human side of the equation was constantly before him. Not only did he remember and make all his superintendents and managers feel that he had a personal interest in them, but the health and welfare of his humblest employees were always given the most careful thought. . .

"During the summer months he rarely remained in the city overnight, but went out to sea on his magnificent yacht, *The Kanawha*. With his wide circle of friends and lovable disposition, he generally managed to have with him some congenial company and an invitation to a trip on the yacht was something that none of his acquaintances ever declined. Among his special friends were Mark Twain and Tom Reed, who at that time was Speaker of the House of Representatives. These two intimates were usually invited together. Once when Reed had just been invited for a week-end trip on *The Kanawha*, he ran across Mark Twain and told him of the invitation before Mr. Rogers had time to invite him. Whereupon Mark Twain jumped to the conclusion that he might possibly be forgotten and sent the following letter:

'My dear Harry:

'Have just seen Tom Reed and he tells me that he is invited to spend the week-end on *The Kanawha*, and I would like to remind you that a boat requires virtue as well as ballast.

'Most sincerely,

'S. L. CLEMENS.'"

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COMPOUND TERMS IN TECHNICAL ENGLISH

TENDENCIES OF THE ENGINEERING PRESS IN THE USE OF THE HYPHEN

ABOUT the use in English composition of compound or hyphened words there has grown up a special literature of some magnitude. There is no more vexatious problem confronting the writer or the compositor than that of when to write two words quite separately, when to join them by a hyphen and when to make them wholly one. The problem is particularly acute in technical writing, where the possible compounds are extremely numerous. Attempts have been made to solve the problem by compilation of lists of terms properly compounded or not, as the case may be; but the field is too large to be covered thus and any such list is out of date almost before it can be published. The formulation of general rules would prove more satisfactory but such formulation has not as yet been established. There is, however, a certain unanimity of usage of the leading engineering publications and a certain definite tendency, as C. W. Park notes in a paper published in the *Bulletin* of the Society for the Promotion of Engineering Education.

Professor Park undertook an investigation of the practice of the technical press in the course of a discussion of the subject with a class in engineering English. Some of his conclusions are interesting:

"In the first place it was noted that in a fairly large proportion of individual journals there was sufficient uniformity in the writing of compounds to indicate an effort at standardization. . . . Second, a comparison of the various journals showed a tendency toward uniformity throughout the group. . . . Incidentally, it may be remarked that these rather surprising facts were only a part of the evidence which showed that engineering journals are rapidly developing a technique of their own.

"The practice of American technical journals with reference to the writing of compound technical words may be briefly stated as follows:

"1. *Write compound nouns without the hyphen;* that is, either as two words in the case of separable, or loose compounds ('cast iron,' 'friction clutch,' etc.), or as one word in the case of inseparable, or close, compounds ('roadway,' 'falsework,' etc.).

"2. *Write adjective compounds with the hyphen; e. g.,* 'four-cylinder automobile,' 'cast-iron frame,' 'low-pressure cylinder,' etc.

"The second rule is subject to some exceptions, including a few close, or inseparable, compounds, *e. g.,* 'overshot wheel,' 'waterproof lining,' etc. More of the exceptions fall under a general rule, which may be stated as follows:

"3. Omit the hyphen wherever the meaning is clear without it; *e. g.,* 'power plant economy,' 'machine tool design,' etc. This rule is made of course in the interest of further simplification. It includes rule No. 1 and is a corrective for rule No. 2."

Professor Park confesses to a personal prejudice in favor of the hyphen in most compound words which cannot be written solid, but admits that "there is much common sense in the practice of technical men" and that "without doing violence to the meaning of compounds, they have been working toward a simpler and more uniform method of writing."

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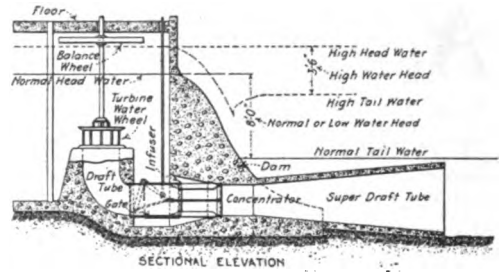
HENRY FORD'S NOVEL HYDRAULIC POWER PLANT

DISCHARGE ACCELERATOR MAINTAINS CAPACITY UNDER LOW-HEAD CONDITIONS

IT has been an inherent defect in water-turbine installations with low heads that high water frequently so decreases the effective head above the tail water that power capacity is seriously diminished. The Herschel "fall increaser," recently devised, is an attempt to make up this deficiency by using the surplus energy resulting from the increased quantity of water accompanying the decreased head. A somewhat similar device has just been applied to a small hydroelectric installation on Henry Ford's farm near Detroit and is described by the designer, Mark A. Replogle, in a paper presented before the December meeting of the American Society of Mechanical Engineers.

As Mr. Replogle describes the situation, the normal full head available for the plant is 8 feet but "high water, with head varying from 2 to 5 feet may persist for weeks at a time, so that provision to meet this condition was necessary. The condition of very high water but practically no head only obtains for a few hours at a time, and no adequate provision can be made for it, except the steam reserve."

There are two turbine units and three penstocks, the middle one of the three serving as a feeder for the others, on each of which is a "turbine discharge accelerator." The principle of the device is described as follows: "These accelerators are a form of draft tube, into which each turbine discharges and into which, also, water from the head race is discharged through a feeder. The head race water accentuates the flow through the draft tube, having the same effect as an added head of head water. . . . The effect of the accelerator on the turbine is to partially remove the pressure at the discharge end without changing the pressure at the intake end. Under ordinary conditions, the pressure on both the head and tail water is 14.7 pounds per square inch alike. If the turbine were to discharge into tail water the pressure on which was, say, only 10 pounds per square inch, the result would be the equivalent of adding slightly over 10 feet head to the turbine, and as far as practical results were concerned, the turbine would now develop energy corresponding to the increased head. This is the effect of the discharge accelerator, which may therefore be likened in principle to a condenser of a steam engine."



HIGH-WATER COMPENSATING DEVICE

The illustration outlines the design of the installation. "Each accelerator consists of a super draft tube, a concentrator and an infuser. . . . The infuser is provided with a gate, by means of which the amount of accelerator water can be varied."

A series of tests showed satisfactory results. "So far," it is stated, "indications are that low heads may be boosted as much as from 100 to 500 per cent, depending on the conditions."

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NEW ELECTRIC LAMP, AN ARC-INCANDESCENT

SMALL ARC IN NITROGEN-FILLED BULB SHOWS HIGH EFFICIENCY

AS the result of experiments by the Edison & Swan company of England, a new type of electric bulb has been devised, involving interesting and novel features. It is described by E. A. Gimingham and S. R. Mullard in a paper before the Institution of Electrical Engineers. The lamp in two typical forms is exhibited in the accompanying illustration, the arrangement of Figure 2 being that for higher candle-powers.

Into a bulb exhausted of air and filled with nitrogen at about two-thirds atmospheric pressure, three leads are introduced. On one is mounted the electrode *E*, Figure 1, a fused tungsten globule; the other two support the ionizing filament *B-B'*. "The positive main lead is divided into two circuits, one of which, *A*, passes through a resistance and the contacts on the electromagnetic switch *C* to one pole of the ionizer *B*, the other being taken through a resistance and the coil on the electromagnetic switch to the positive electrode of the arc circuit *E*. The negative main lead is connected to the remaining ionizer lead *B'*.

"In operation the current first passes through the ionizer circuit, causing the filament to incandesce at a temperature sufficient to ionize the gas between it and the positive electrode. At first a small current flows in the arc circuit, this current rapidly increasing until the cut-out is operated. This breaks the ionizer circuit and the arc is 'struck,' the striking being assisted by the removal of the ionizer circuit, which of course shunted the arc circuit. The heat rising from the arc causes the expansion strip *F* to warp, and this moves the arc to another position on the ionizer.

"On switching off the current the electrode returns to its original position, having left the inactive part and coming to rest opposite the still active portion of the ionizer. By this means the lamp may be restarted at any period of its life."

For the larger sizes, as shown in Figure 2, "the expansion strip is dispensed with, use being made of the fact that in the more powerful arcs there is a greater tendency for the arc to pass across the shortest gap. In this case, after striking from the filament to the edge of the electrode, the arc rises to the thickened portion immediately opposite."

The authors compare the characteristics of the lamp with those of other types as follows: "As compared with the carbon arc lamp no regulating mechanism is required, and there is therefore a saving in the initial cost of production. The loss of light due to obstruction by the electrodes is small compared with that in the carbon arc, and there is no trouble from flickering or from the arc wandering. The arc is completely enclosed so that there is no danger from fire. No re-carboning is required, and the lamp needs no attention whilst in use. The light-giving surface for the same output is greater than the crater of the carbon arc, and the electrodes can be so arranged as to concentrate the light in any desired direction.

"Filaments of incandescent lamps are always distributed round the stem and thus occupy a fairly large area, whereas in the new lamp the light-giving surfaces are concentrated in the center of the bulb. In

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the same way that a carbon lamp appears yellow in comparison with the ordinary half-watt lamp, so does the latter appear yellow when contrasted with the new incandescent arc. For high candle-power lamps the bulbs are much smaller than for metal-filament lamps of corresponding candle-power, *e. g.* electrodes to give 500 candle-power can be placed with safety in a bulb 4 inches in diameter."

Other features of the lamp are given as follows: "A representative efficiency curve shows the efficiency for the normal working current to be about 0.5 watts per International candle-power, or 2 candle-power per watt. The current may be increased until the tungsten reaches the sputtering point, at which the efficiency is about 0.3 watts per candle-power. . . .

"Lamps have been made with a life of 500 hours, and it is hoped that further experiment will make it possible to obtain a true half-watt lamp with a life of 800 hours. . . .

"As compared with the carbon-filament lamp (3.5 watts per candle-power) with an intrinsic brilliancy of about 375 candle-power per square inch, and metal-filament lamps giving 1,000 candle-power per square inch, the intrinsic brilliancy of the new lamp at an efficiency of 0.5 watt per candle-power . . . is approximately 10,000 candle-power per square inch. . . .

"A great advantage of a lamp of this type is its adaptability (by altering the shape and position of the electrodes) in so varying the light distribution as to make it most suitable for the particular purpose for which the lamp is required. Where even illumination is required in all directions, spherical electrodes are most suitable. Electrodes can be made of any desired shape, however, and a flat plate or disk mounted vertically is an ideal light source for projection purposes.

"The lamp is made for both alternating and continuous-current circuits, and the present intention of the Edison & Swan Company is to put forward only the continuous-current lamp in its present form for optical projection and general scientific work where a concentrated point source of light is required. The lamp is so suitable for projection work that there is every reason to believe it will supersede all other sources of light for this purpose. It

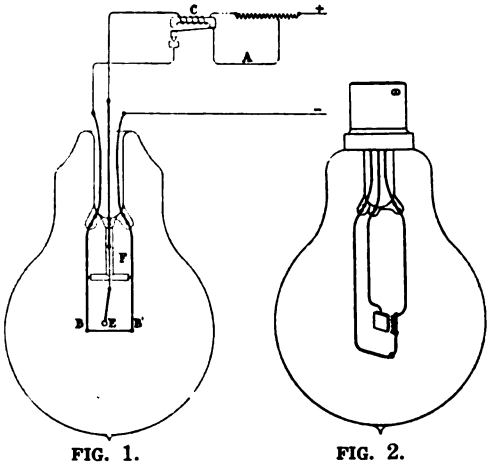

FIG. 1. FIG. 2.

gives constant, uniform screen illumination, whilst there is no flickering and no danger of fire in kinematograph work as there often is from the intense heat of the ordinary carbon arc. The bulb of the lamp, although small, does not become so hot as those of the half-watt metal-filament lamps. Moreover the lamp requires no attention whilst burning, so that the whole of the operator's time is free to attend to his apparatus. . . .

"The lamp is very suitable for use in small searchlights, for daylight and night signaling, and as projection arcs for stage purposes. It should prove useful in photography and for the purpose of color-matching by artificial light."

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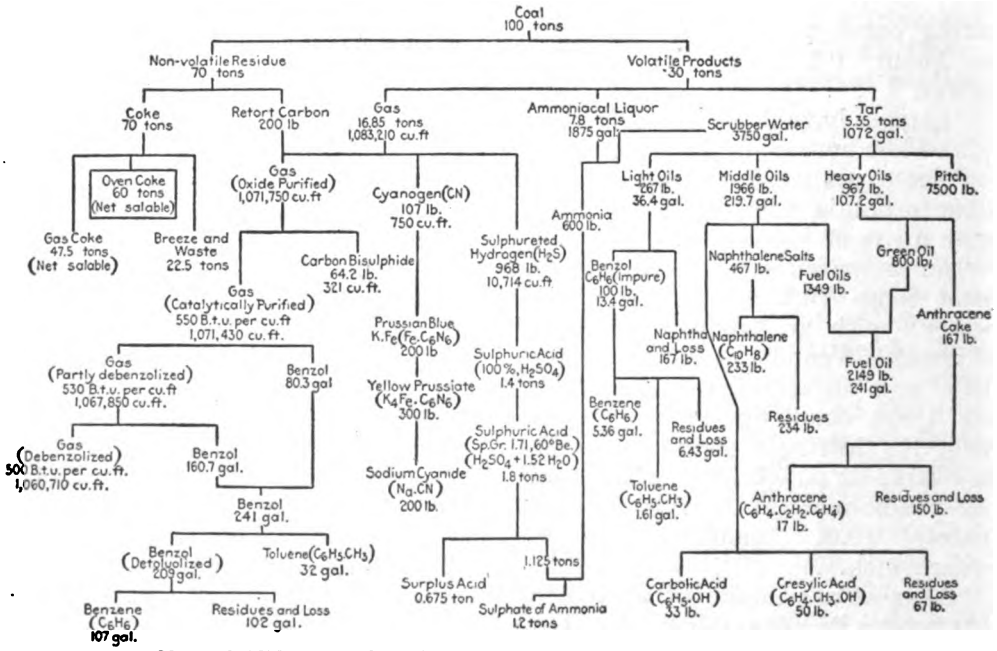
Byproducts From Coal Tar

RELATIONS BETWEEN THE SEVERAL PRODUCTS OF COAL GASIFICATION

INCREASED popular interest has been evidenced in the question of coal tar products since the War cut us off, at least in part and temporarily, from some of the most important of these substances. It is to be hoped that the United States will be able to establish its chemical industries now on a basis that will render it henceforth reasonably independent of foreign supplies. The importance of the coal byproducts in the chemical industry and consequently in a wide variety of manufactures cannot be over-emphasized. Dyes, drugs, explosives, fertilizers, wood preservatives, and a host of other products come in whole or in part from coal.

In the *Engineering and Mining Journal* there is outlined the scope of the coal-tar industry, illustrated with an interesting and intelligible "family tree" of the principal products. This chart is reproduced herewith. The *Journal* notes that:

"Tar is an exceedingly complex substance, consisting of a mixture of more than 200 different chemical compounds, and of course varies considerably in quality and quantity per ton of coal distilled, according to the class of coal and the temperature of distillation. . . . The primary distillation of one ton of average gas tar will produce approximately: Ammoniacal liquor, 5 gal.; crude naphtha, 5.6 gal.; light oils, 26 gal.; creosote oils, 17 gal.; anthracene oils, 38 gal.; pitch, 1 cwt.


Coal 100 tons
Non-volatile Residue 70 tons
Volatile Products 30 tons
Coke 70 tons
Retort Carbon 200 lb
Gas 16.85 tons 1,083,210 cu.ft
Ammoniacal Liquor 7.8 tons 1875 gal.
Scrubber Water 3750 gal.
Tar 5.35 tons 1072 gal.
Oven Coke 60 tons (Net salable)
Gas (Oxide Purified) 1,071,750 cu.ft
Cyanogen(CN) 107 lb. 750 cu.ft.
Light Oils 267 lb. 36.4 gal.
Middle Oils 1966 lb. 219.7 gal.
Heavy Oils 967 lb. 107.2 gal.
Pitch 7500 lb.
Ammonia 600 lb.
Gas Coke 47.5 tons (Net salable)
Breeze and Waste 22.5 tons
Carbon Bisulphide 64.2 lb. 321 cu.ft.
Sulphureted Hydrogen(H_2S) 968 lb. 10,714 cu.ft
Benzol C_6H_6(impure) 100 lb. 13.4 gal.
Naphthalene Salts 467 lb.
Fuel Oils 1349 lb.
Green Oil 800 lb.
Gas (Catalytically Purified) 550 B.t.u. per cu.ft 1,071,430 cu.ft.
Prussian Blue $K.Fe(Fe.C_6N_6)$ 200 lb
Naphtha and Loss 167 lb.
Naphthalene ($C_{10}H_8$) 233 lb.
Anthracene Cake 167 lb.
Gas (Partly debenzolized) 530 B.t.u. per cu.ft 1,067,850 cu.ft.
Benzol 80.3 gal
Sulphuric Acid (100%, H_2SO_4) 1.4 tons
Yellow Prussiate ($K_4Fe.C_6N_6$) 300 lb.
Fuel Oil 2149 lb. 241 gal.
Benzene (C_6H_6) 5.36 gal.
Residues and Loss 6.43 gal.
Residues 234 lb.
Gas (Debenzolized) 500 B.t.u. per cu.ft. 1,060,710 cu.ft.
Benzol 160.7 gal.
Sulphuric Acid (Sp.Gr. 1.71, 60°Be.) (H_2SO_4 + 1.52 H_2O) 1.8 tons
Sodium Cyanide ($Na.CN$) 200 lb.
Toluene ($C_6H_5.CH_3$) 1.61 gal.
Anthracene ($C_6H_4.C_2H_2.C_6H_4$) 17 lb.
Residues and Loss 150 lb.
Benzol 241 gal.
Benzol (Detoluolized) 209 gal.
Toluene($C_6H_5CH_3$) 32 gal.
1.125 tons
Surplus Acid 0.675 ton
Carbolic Acid ($C_6H_5.OH$) 33 lb.
Cresylic Acid ($C_6H_4.CH_3.OH$) 50 lb.
Residues and Loss 67 lb.
Benzene (C_6H_6) 107 gal.
Residues and Loss 102 gal.
Sulphate of Ammonia 1.2 tons

THE MORE COMMON DERIVATIVES OF THE DESTRUCTIVE DISTILLATION OF COAL

It is stated that during 1915 over a dozen plants were built or nearly completed in this country and Canada for the production of benzol, largely in connection with byproduct coke ovens; such is the war demand for this commodity.

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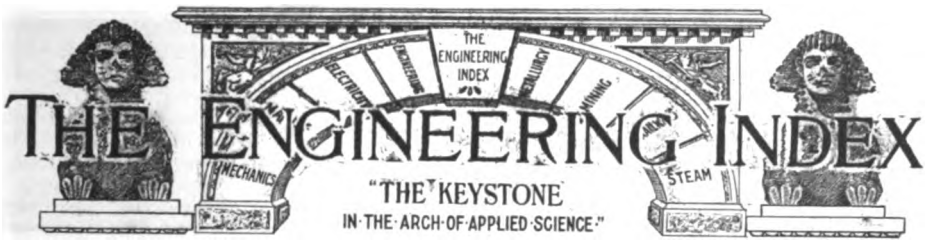

Including a current record of new books.

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☛ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

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CIVIL ENGINEERING

BRIDGES

Caissons

Building Concrete Caissons in the Platte River. (66298 A) J. H. Merriam. Ills. 2500 w. R G—Dec. 17, 1915. Bridge building near Ashland, Neb.

Concrete

Zwei neue Eisenbetonbrücken uber die Pegnitz. (66205 B). Hermann Goebel. Ills. 1500 w. B u E—Nov. 3, 1915. Reinforced-concrete bridges over Pegnitz.

Construction of Washington St. Arch Bridge at Indianapolis (66357). Ills. 2200 w. E. N.—Dec. 9, 1915.

A 2223-Ft. Concrete-Arch Bridge Built on Reverse Curve (66834). A. M. Richter. Ills. 4300 w. E N—Dec. 30, 1915. Third Ave. bridge across Mississippi at Minneapolis.

Lemieux Island Bridge, Ottawa (66784). L. McLaren Hunter. Ills. 800 w. Cn E—Dec. 23, 1915. Four-span reinforced concrete arch.

Design of a 242-Ft. Arch Span Over the Pit River in Shasta County, California (66498). Ills. 1500 w. E & C—Dec. 15, 1915. Reinforced concrete highway structure.

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The Cherry Street Bridge, Toledo, Ohio (66727 D). 2000 w. A S C E—Dec., 1915. Discussion of paper by Clement E. Chase, Jun.

Replacing Water-Main Bridge with Concrete Arch (66545). Ills. 800 w. E N—Dec. 16, 1915. Aqueduct in city of Washington built about 1852 now being inclosed in reinforced concrete arch bridge.

Erection

Piecemeal Erection of a Bridge on the Boston & Maine R. R. (66138). K. W. Lemcke. Ills. 1600 w. E N—Dec. 2, 1915. New trusses on old piers; two-story falsework.

Hell Gate

Erection of the Hell Gate Bridge (66467). Walter J. Parsons. Ills. 3000 w. Wis E—Dec., 1915.

Hell Gate Bridge, New York (66331 A). Ills. and Plate. 3000 w. Enr—Nov. 26, 1915.

The Erection of the Hell Gate Arch (66647 A). C. S. Whitney. Ills. 2500 w. C C E—Dec., 1915.

Highway

Some data on Waterway Areas Required for Highway Bridges (66499). W. S. Gearhart. Abstract of paper before the Pan-American Road Cong. 1500 w. E & C—Dec. 15, 1915. Approximate determination.

Concerning the Use of Steel Highway Bridges in Iowa (66822). J. H. Ames. Ills. 2000 w. E & C—Dec. 29, 1915. Conditions affecting design, life, etc.

Military

I ponti militari (66276 B). Cesare Chiodi. Ill. 5000 w. M T—Nov. 20, 1915. Serial, 1st part. Methods of construction of all types of bridges used in war.

Plate Girders

Record-Breaking Plate Girders for Nickel Plate R. R. (66350). Ills. 1200 w. E N—Dec. 9, 1915. Grade crossing work at Chicago.

Quebec

Progress on the Erection of the New Quebec Bridge (66760). H. P. Borden. Ills. 700 w. R A G—Dec. 24, 1915.

The Erection Plant for the Quebec Bridge (66805 A). Ills. 2000 w. Eln—Dec. 17, 1915. Serial, 1st part. Particularly crane equipment used.

Railway

Design of Timber Railway Bridges in Queensland (66316 N) W. J. Doak. Ills. 3000 w. Cw. E—Nov., 1915. Data of successful spans in use.

Solid Deck Trestles and Bridges on the Illinois Central (66638 A). Ills. 700 w. R G—Dec. 3, 1915. Details of reinforced concrete trestles.

Suspension

Design Features of the Dewey Suspension Bridge Across the Grand River, Near Dewey, Utah (66092). Ills. 1500 w. E & C. Dec. 1, 1915. Details.

Swing

Glebe Island Electrically Operated Swing Bridge (66314 N). Ills. 1200 w. Cw. E—Nov., 1915. Features of construction.

The Lachine Canal Swing Bridge (66389 A). Max McD. Ills. 1000 w. R E & M W—Dec., 1915. Bridge of Can. Pac. Ry. in Quebec Province.

Neubau der Achereggbrücke über die See-Enge des Vierwaldstättersees bei Stansstad (66279 B). A. Rohn. Ill. 3000 w. S B—Dec. 4, 1915. New end-swing bridge over narrows of Swiss lake.

Moving and Placing American Railway Drawbridges by Means of Barges (66555 A). Ills. 2500 w. Enr—Dec. 3, 1915. At Milwaukee and on Harlem River.

Three-Hinge

Detroit-Superior 591-Foot Steel Arch Successfully Swung by Toggle Adjustment (66791). Ill. 1200 w. E R—Dec. 25, 1915. Erection methods.

Three-Hinged Arch Girders with Vertical Ends Provide Barge Canal Clearance (66154). Ills. 1000 w. E R—Dec. 4, 1915. Special design built at Lockport, N. Y.

Viaducts

High Masonry Arch Viaduct in France Designed as a Two-Level Structure (66612) Ills. 800 w. A. Dumas in *Le Genie Civil.* E R—Dec. 18, 1915. Font-pedrouse viaduct spanning deep ravine.

Bloor Street Viaduct Construction, Toronto (66623) Ills. 1200 w. Cn E—Dec. 16, 1915. Year's progress on two large steel and concrete bridges.

CONSTRUCTION

Buildings

Wreck 15-Story Building and Replace with 17-Story Structure in 142 Days (66149). Ills. 900 w. E R—Dec. 4, 1915. Rapid work in Chicago.

Concrete

The Manufacture and Sale of Concrete Burial Vaults (66504). 2800 w. C-C A—Dec., 1915. Materials and methods.

Concrete Buildings

Ferkelhalle Husum (66204 B). Ills. 1200 w. B u E—Nov. 3, 1915. Calculation and construction details of concrete pig market in city of Husum.

Earthquakes

Structural Engineering and Earthquakes (66786). John C. Branner. 3000 w. E R—Dec. 25, 1915. Need of study of phenomena.

Fire Protection

Fire Fighting and Fire Prevention. (66048). Frank Williams. Ills. 2500 w. PE, C—Dec. 1, 1915. Serial, 1st part. System of modern loft building.

The Hollow Metal Door in Fireproof Buildings (66649 A). H. A. Seeley. Ills. 2000 w. C C E—Dec., 1915. Materials, construction, tests, etc.

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Floors

Slab Design to Use Less Concrete Is Verified by Experiments (66505). Robert B. Melvin. Ills. 1800 w. C-C A—Dec., 1915. Opposed to commonly accepted theories.

Creosoted Wood Block Floors for Railroad Buildings (66586). Ills. 3500 w. R A G—Dec. 17, 1915. Precautions and results.

Foundations

Foundations (66565 N). Charles T. Main. 18 pp. A S M E—Dec., 1915. Testing soil; excavation; structures; stability, etc.

Pile-and-Mat Foundation for Power House in Marsh (66353). Ills. 600 w. E N—Dec. 9, 1915. Method used at Essex power station, of Newark, N. J.

Die Berechnung der nachträglichen Grundmauerwerkverbreiterung, Bauweise Heimbach (66203 B). Robert Schönhöfer. Ills. 2000 w. B u E—Nov. 3, 1915. Heimbach method for calculating stepped-out foundation walls.

Grain Elevators

The Design and Equipment of the Clyde Trustees' New Granary at Meadowside (66484 N). George H. Baxter. Ills. 38 pp. I E S S—Oct., 1915. General description.

The Failure and Righting of a Million-Bushel Grain Elevator (66719 D). Alexander Allaire. Ills. 6500 w. A S C E—Dec., 1915. At Winnipeg.

Pile-driver

Construction Features and Cost of Pile-driver Built for General Use Around Water, Los Angeles, Cal. (66745). W. D. Jones, Ills. 1200 w. E & C—Dec. 22, 1915. For wharves.

Pipe Lines

Some Difficult Work in Large Gas Pipe Laying Under the Lachine Canal and Adjacent Swamps (66387). C. H. Osler. Ills. 3500 w. A G L Jl—Dec. 13, 1915. Work at Montreal.

Power Station

Steel Framing of a Large Power Station (66832). Ills. 2700 w. E N—Dec. 30, 1915. Essex generating station, Newark, N. J.

Roofs

Insulating Concrete Roofs Against Condensation (66837). Albert M. Wolf. Ills. 4000 w. Cn E—Dec. 30, 1915. Methods and relative value.

Sewers

See same heading under *Municipal.*

Stacks

Design and Construction of Chimneys for Railways (66589). Ills. 3500 w. R A G—Dec. 17, 1915. Types, points considered in deciding details.

Tunnels

The Astoria Tunnel Under the East River for Gas Distribution in New York City (66724 D). Ills. 1800 w. A S C E—Dec., 1915. Discussion of John Vipond Davies' paper.

Bypass Around Leaky Tunnel in Catskill Aqueduct (66351). Charles A. Hirschberg. Ills. 1500 w. E N—Dec. 9, 1915. Methods used.

Repairing a Tunnel Lining Under Difficult Conditions (66591). Ills. 1500 w. R A G—Dec. 17, 1915. Concrete atomizer used by C G W at Winston, Ill.

Underpinning

Tests of Soil and Methods of Underpinning Buildings Adjoining Subway Construction in William St., New York (66743). John F. Greathead. Abstract from *Pub. Serv. Rec.* Ills. 4000 w. E & C—Dec. 22, 1915. Methods in connection with subway.

Warehouses

The Bingham Warehouse, Cleveland, Ohio (66469). R. B. Buettell. Ills. 2000 w. Wis E—Dec., 1915. Heaviest type of reinforced concrete.

Water Tanks

Elevated Water Tanks (66251 N). 8 pp. T S—Dec., 1915. Relations to fire fighting; hazards; proper construction.

IRRIGATION AND RECLAMATION

Irrigation Systems

Some Principles Governing the Design and the Operation of Irrigation Systems (66624). 1500 w. Cn E—Dec., 1915. From report of S. G. Porter. Reference to Alberta.

Montana

Water for Prickly Pear Irrigation Project Raised 160 Feet with Financial Success (66150). Ills. 1200 w. E R—Dec. 4, 1915. Electrically pumped supply near Helena.

Pumping

Land Drainage by Means of Pumps (66436 N). S. M. Woodward. 59 pp. Ills. U S D A, Bul 304—Nov. 19, 1915. Data from investigation.

Run-Off

The Run-Off Problem in Draining Irrigated Lands (66744). C. G. Elliott. 800 w. E & C—Dec. 22, 1915. Determining amount of water applied and its distribution.

MATERIALS OF CONSTRUCTION

Concrete

Materials vs. Methods—Testimony of Moving Pictures in the Study of Concrete (66147). Nathan C. Johnson. Ills. 3500 w. E R—Dec. 4, 1915. Serial, 1st part. Evils of poor mixing and improper placing.

Concrete Aggregates

Concrete Aggregates: Classification, Sources, Physical Condition, Requirements (66503). William M. Kinney and Duff A. Abrams. 4000 w. C-C A—Dec., 1915. Serial, 1st part.

Corrosion

The Corrosion of Metals (66692 A). 3500 w. Eng—Dec. 10, 1915. Editorial review of discussion before Faraday Society.

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The Relative Corrodibilities of Iron and Steel (66694 A). J. Newton Friend. 3500 w. Enr—Dec. 10, 1915. Contribution to general discussion before Faraday Society, Dec. 8, 1915.

Explosives

See same heading under MINING & METALLURGY, *Mine Operation.*

Gravel

Sand and Gravel Washing and Grading Plant (66738). C. B. Breed. Ills. 1500 w. E N—Dec. 23, 1915. Served by dragline scraper.

Hydrated Lime

Improving Concrete by the Use of Hydrated Lime (66407 A). 1800 w. Mun E—Dec., 1915. Experience and successful uses.

Lumber

Hints for the Ordering of Lumber (66587). Abstract of paper read at Albuquerque, N. M. T. O. Ward. 1000 w. R A G—Dec., 17, 1915. Suggestions for the purchaser.

Rubber

Rubber from Tree to Factory (66507 A). Walter C. Mullett. 1800 w. C R C—Nov. 12, 1915. Brief account of gathering and preparation.

Tars

The Development of Refined Tars for Use in Road Construction and Maintenance (66088). Philip P. Sharples. Read before Nat. Ex. of Chem. Ind. 2500 w. M & C E—Dec. 1 1915. Development of the whole industry.

MEASUREMENT

Barometers

Aneroid Barometers for Aviators (66493). P. Richard Jameson. 1200 w. C A M—Dec., 1915. Errors and corrections.

Beams

Elastic Curves and Influence Lines Simplify Analysis of Beams (66611). J. P. J. Williams. Diagrams. 4000 w. E R—Dec. 18, 1915. Graphical diagrams for deflections and reactions.

Catenary

Ueber die Kettenlinie (66235 B). A. Kiefer. Ills. 1200 w. S B—Nov 27, 1915. Calculation and characteristics of the catenary.

Columns

Progress Report of the Special Committee on Steel Columns and Struts (66730 D). Ills. 2500 w. A S C E—Dec., 1915.

Combined Fire and Load Tests of Building Columns (66358). Ills. 1800 w. E N—Dec. 9, 1915. Method of conducting.

Cubic Performance

"Cubic Performance" (66610). Leslie C. Frank. 1600 w. E R—Dec. 18, 1915. Defines term and explains use on sewage and water treatment.

Curves

Fitting Equations to Plotted Points (66468). J. B. Kommers. 1500 w. Wis E—Dec., 1915. Equations of the parabolic, hyperbolic, logarithimic, and the power series types of curves.

Evaporation

A Study of the Depth of Annual Evaporation from Lake Conchos, Mexico (66726 D). Ills. 6000 w. A S C E—Dec., 1915. Discussion of paper by Edwin Duryea, Jr., and H. L. Haehl.

Hydraulic Jump

The Hydraulic Jump in Open-Channel Flow at High Velocity (66725 D). Ills. 3800 w. A S C E—Dec., 1915. Continued discussion of Karl R. Kennison's paper.

Indeterminate Stresses

Welchen Einfluss übt der Grad der statischen Unbestimmheit eines Systems auf dessen Querschnittsbemessung aus? (66206 B). G. Kaufmann. Ills. 5000 w. B u E—Nov. 3, 1915. Mathematical enquiry into influence on calculation of sections, of degree in which system is statically indeterminate.

Slabs

Results of Some Tests to Determine the Load Distribution Through Reinforced Concrete Slabs (66821). Ills. 2500 w. E & C—Dec. 29, 1915. To determine effective width.

Soil Pressure

Cohesion in Earth: the Need for Comprehensive Experimentation to Determine the Coefficients of Cohesion (66721 D). William Cain. 3500 w. A S C E—Dec., 1915. Experiments.

Structural Steel

Errors in Structural Steel Designing (66342). Edward Godfrey. Ills. 2000 w. E & C—Dec. 8, 1915. Description.

MUNICIPAL

Activated Sludge

The Treatment of Sewage by Aeration in the Presence of Activated Sludge (66085). Edward Bartow. Read at San Francisco. Ills. 3000 w. M & C E—Dec. 1, 1915. Process; properties of sludge; applications.

Atmospheric Pollution

The character and Extent of Atmospheric Pollution in English and Scotch Towns, with Notes Upon a New Type of Recording Actinometer (66462). John B. C. Kershaw. Ills. 3000 w. M & C E—Dec. 15, 1915.

Atmospheric Pollution in English and Scottish Towns (66079 A) John B. C. Kershaw. Ills. 3000 w. Enr—Nov. 19, 1915. Results of observations.

City Planning

Urbanisme et la reconstruction des villes detruites au cours de la guerre (66229 N). G. Courtois. 27 pp. S I C F Pro-Ver—Oct. 29, 1915. Principles to be followed in rebuilding towns destroyed in the war.

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Making an Everlasting Tunnel Through the Bed of the East River

tubes running from Old Slip, Manhattan, to Clark Street, Brooklyn. At the Manhattan end two large steel caissons, one for each tube, have been sunk down to rock and through it to subgrade. These caissons are 31 feet square outside and 24 feet square inside. In opposite walls are openings 19 feet 6 inches in diameter through which the shield can pass out. During the sinking of the caissons these openings were closed by means of steel bulkheads heavily reinforced with I-beams. At the Brooklyn end of the tunnel work on the two tubes will be extended in each direction from a double caisson. This enormous steel caisson measures 32 by 57 feet. The most suitable location for these caissons was on Furman Street, along the Brooklyn waterfront. But immediately behind the caisson are the Columbia Heights, which rise 68 feet above Furman Street. It was realized that this huge bluff of sand and gravel would tend to thrust the caisson out of line, and so the bank had to be excavated to give it a more gradual slope.

Solidifying the Sand Outside the Caisson.

It is always a difficult matter to break out of a caisson and start a horizontal drift through water-bearing material. In order to expedite this work and reduce the dangers commonly encountered, a very novel system invented by Mr. John F. O'Rourke is being used. In the bulkheads closing the openings for the shields, a number of holes are provided, each closed temporarily by caps. Also around each shield opening there is a ring of capped holes. After the caisson has been sunk down to grade, pipes are introduced through these holes, and forced out to a distance of 10 feet from the face of the caisson. Through these pipes, which are formed with perforated heads, grout is forced while the pipes are gradually withdrawn and at the same time rotated. (See Fig. 2.) The result of this is that a mass of cement is forced out into the sand, and soon sets, forming a solid wall. (See Fig. 3.)

Such a wall has been formed in one of the shield openings so far, and the bulkhead has been removed without danger of flooding the caisson. The method of procedure now is to assemble the shield within the caisson on a cradle that leads to the opening. Above

These clippings and views, reproduced through the courtesy of the Scientific American, illustrate some ALPHA concrete work in connection with the new East River tunnels connecting Manhattan and Brooklyn.

ALPHA CEMENT has been used extensively in a long list of undertakings where concrete has had to resist sea-water action, hurricanes, unusual compression or other exacting tests. The Galveston Sea Wall, New York Aqueduct, P. R. R. Hudson River Tunnels, Detroit River Tunnels, Holyoke Dam, etc., are examples.

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grout can be pumped into the sand to solidify it. Our drawing indicates these openings in the apron, but the grout pipes are not shown. Of course, after the shield has entered the opening in the caisson, it will be a simple matter to prevent water from leaking around it by using suitable packing. When the shield has proceeded far enough beyond the caisson the tunnel will be closed by a bulkhead in which an airlock will be introduced according to the usual practice. Thereupon the deck will be removed from the caisson, for the air pressure can be confined to that part of the tunnel which lies between the face of the shield and the airlock.

Sand Packing Behind the Shield.

The contractors of the present tunnel have learned a lesson from the experiences of the builders of the existing subway and of other subways driven by the shield method. As the shield fits over the end of the tunnel, it must necessarily be of larger diameter than the tunnel lining, and consequently it makes a larger hole in the ground than is necessary. This forms a void around the tunnel lining that is gradually filled by settling of the ground overhead. When the existing

it a deck is being built across the caisson so as to form a large working chamber in which compressed air may be maintained. After the shield has been erected a ring of the cast iron lining will be set up within the tail of the shield in the ordinary manner, and the hydraulic jacks of the shield will be operated. At first they will force the rings back instead of forcing the shield forward. The jacks will be withdrawn and a new ring of lining will be set up in advance of the first ring. Ring after ring will be added until the lining is forced against the opposite wall of the caisson, when further operation of the jacks will cause the shield to move forward.

After the shield passes through the opening in the caisson, the cemented sand ahead of it will have to be cut away in advance of its cutting edge. The upper part of the shield will project forward as indicated in Fig. 3 to form an "apron." Grout pipes will lead up to and open out through the face of the apron, so that when the shield emerges from the grouted sand fresh

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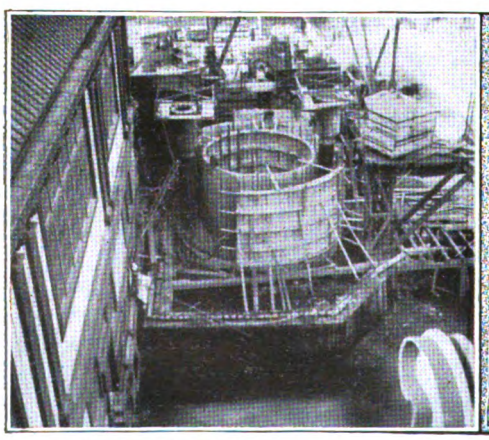

Putting up the forms for the circular concrete caisson

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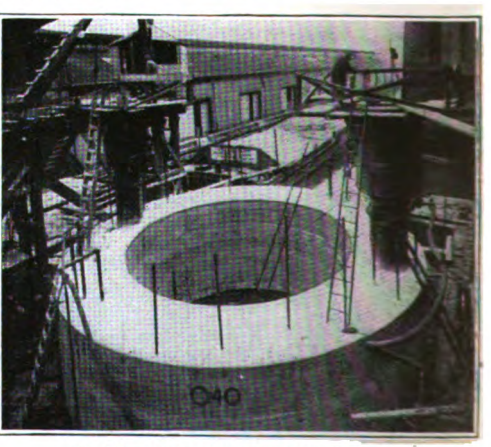
ALPHA THE STANDARD PORTLAND CEMENT



The 35-foot concrete caisson as it was being lowered to rock

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Benefits Derived by an Urban District Adopting a Town Planning Scheme (66685 A). W. Louis Carr. Also discussion. 6500 w. S M C E—Dec. 10, 1915. Benefits to the public and to landowners.

Cubic Performance

See same heading under *Measurement.*

Fire Alarms

San Francisco's New Fire Alarm Station (66119). James M. Barry. Ills. 3000 w. Mun Jl—Dec. 2, 1915. Capacity for 130 circuits. Method of operation.

Fire Protection

City Fire Limits (66525 N). Albert Blauvelt. Ills. 2500. A W A—Dec., 1915. The need of higher requirements.

Lille

Abwasserbeseitigung und Kehrichtbehandlung in Lille (66246 B). Paul Keim. 1500 w. G-I—Dec. 4, 1915. Methods of handling sewage and refuse in Lille.

Power Plant

See Municipal Plant under ELECTRICAL ENGINEERING, *Generating Stations.*

Refuse Disposal

Planning for Garbage Collection (66538). 3000 w. Mun-Jl—Dec. 16, 1915. How to determine number and capacity of vehicles, time required for collecting and relative costs.

The Collection and Disposal of Garbage in Dayton, O. (66500). J. E. Barlow. Abstract of paper before Am. Soc. of Munic. Imp. 2000 w. E & C—Dec. 15, 1915. New reduction plant having novel features.

St. Louis

River Terminals and a Boulevard System for St. Louis (66456 A). Julius Pitzman. 3500 w. A E S—Nov., 1915. Defects in city development and remedies.

Sewage Disposal

The Disposal of Sewage by Dilution: a Bio-Chemical Method of Purification (66684 A). W. E. Adeney. Read before Inst. of San. Engrs. 7000 w. S M C E—Dec. 10, 1915. Practice, factors to be considered.

The Construction and Working of the Royal Military Camp Sewage Disposal Works at Ripon (66072 A). Arthur W. Smith. 1500 w. S M C E—Nov. 19, 1915. Engineering details.

Sewer Cleaning in Atlantic City (66537). Frederick T. Parker. Ills. 1500 w. Mun Jl—Dec. 16, 1915. Methods used.

Sewerage

The South End Sewer System of Boston (66516 B). Edgar S. Dorr. Map & Ills. 5500 w. B S C E—Dec., 1915. Explains conditions and describes the pumping station and other relief work.

Sewers

How a Contractor is Laying Small Sewers in Boston (66334 A). Daniel J. Haner. 2000 w. E C—Oct., 1915. Comparison of hand and machine methods.

Constructing a Large Concrete Sewer at Chicago (66741). Ills. 1400 w. E N—Dec. 23, 1915. Plant and methods.

Street Cleaning

New York Street Cleaning (66120). Ills. 2000 w. Mun Jl—Dec. 2, 1915. Itemized costs.

ROADS AND PAVEMENTS

Bituminous

See Tars under *Materials of Construction.*

Brick

Brick Pavement Construction by Day Labor (66824). John C. Hiteshew . Ills. 3000 w. Mun Jl—Dec. 30, 1915. Methods and costs.

Building a Monolithic Brick Road near Monticello, Ill. (66282). Chas. P. Stivers. Ills. 1500 w. Cnr—Dec. 15, 1915. Details of procedure.

Concrete

Colonel Sohier Tells of California's Concrete Roads (66148). 1500 w. E R—Dec. 4, 1915. Construction and maintenance.

Coleman du Pont Concrete Road (66833). Ills. 1400 w. E N—Dec. 30, 1915. Methods of construction in Delaware.

Experimental Concrete Roadway, Sacramento, California (66546). A. J. Cleary. Ills. 1500 w. E N—Dec. 16, 1915. Various thicknesses, plain and reinforced.

Contract Work

Millions for Paving Controlled by Handful of Pins (66382). William H. Connell. Ills. 2500 w. E R—Dec. 11, 1915. Planning board to classify highway contract work, Philadelphia.

Hydrated Lime

Hydrated Lime in Concrete Road Construction (66241). Ills. 1500 w. G R—Dec. 4, 1915. Review of success thus far.

London

Arterial Roads in Greater London (66815 A). W. R. Davidge. From a paper read before the Town Planning Inst. Short discussion. 2500 w. S M C E—Dec. 17, 1915. Present and future needs.

Los Angeles County

Highway Work in Los Angeles County, California (66240). 5000 w. G R—Dec. 4, 1915. Administration, construction and maintenance method.

Maintenance

Road Maintenance (66711 A). George C. Scales. 1800 w. E C—Nov., 1915. Systems in United States.

Gravel Roads of New Hampshire; Patrol Maintenance (66352). Ills. 3300 w. E N—Dec. 9, 1915. Details, for heavy traffic.

Ottawa

Bank Street Pavement, Ottawa (66125). Ills. 900 w. Cn E—Dec. 2, 1915. Type of construction and cost.

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Pike's Peak

Pike's Peak Highway, Colorado (66737). R. C. Hardman. Ills. 1000 w. E N—Dec. 23, 1915. Scenic road.

Road Materials

Progress Report of the Special Committee on Materials for Road Construction and on Standards for Their Test and Use (66728 D). 7500 w. A S C E—Dec., 1915.

Methods for the Examination of Bituminus Road Materials (66585 N). Prévost Hubbard and Charles S. Reeve. Ills. 48 pp. U S D A, Bul 314—Dec. 10, 1915. Scheme of examination, tests, etc.

South Dakota

Lawrence County Roads and How It Was Done (66238 N). George V. Ayres. Ills. 1600 w. Pah Qt—Dec., 1915. Financing and methods of constructing in Black Hills.

Surveying

Road Surveying cum Road Surveyor's Position (66073 A). W. J. Brooke. 1800 w. S M C E—Nov. 19, 1915. Triennial system; road materials, etc.

Test Pavements

Present Condition of Second Avenue Test Pavements (66830). Henry Willes Durham. 1900 w. E N—Dec. 30, 1915. Summary of experiments in New York.

WATER SUPPLY

Alabama

Impounded Waters of Alabama in Relation to Public Health (66527 N). Edgar B. Kay. 7500 w. A W A—Dec., 1915. Character, need of careful sanitary surveys.

Algae

The Effect of Algae on Bicarbonates in Shallow Reservoirs (66530 N). S. T. Powell. Diagrams. 1200 w. A W A—Dec., 1915. Tests showing rapid changes in chemical composition of water.

Alum

The Arsenic Content of Filter Alum (66521 N). Edward Bartow and A. N. Bennett. Short discussion. 3000 w. A W A—Dec., 1915. Methods of analysis and conclusions.

The Manufacture of Sulphate of Alumina at the Columbus Water Softening and Purification Works (66529 N). Charles P. Hoover. Also discussion. 3500 w. A W A—Dec., 1915. Plant for making alum to coagulate water.

Analysis

The True Object of Water Analysis (66531 N). Frank L. Rector. 700 w. A W A—Dec., 1915. Results of investigation.

Assessments

Assessing Costs of Extensions in a Municipally Owned Plant (66523 N). D. A. Reed. Discussion. 4500 w. A W A—Dec., 1915. Methods, principles, results involved.

Cubic Performance

See same heading under *Measurement.*

Dams

The Action of Water Under Dams (66723 D). 1800 w. A S C E—Dec., 1915. Continued discussion of J. B. T. Colman's paper.

The Construction of Earth Dams (66548 A). R. L. Daugherty. Ills. 1000 w. S Jl E—Dec., 1915. Calaveras dam.

Hydraulic Fill Method Used to Throw Temporary Dam Across Wide Stream (66792). Ills. 2000 w. E R—Dec. 25, 1915. Entire flow of Colorado River diverted into Imperial Valley temporarily to save crops.

Low Concrete Dam at Harrisburg Across Susquehanna River (66828). Ills. 2700 w. E N—Dec. 30, 1915. General description.

The Twin Cities' Interest in the High Dam (66455 A). Adolf F. Meyer. 5000 w. A E S—Nov., 1915. Source of power and effect on navigation.

Concrete and Fine Earth Form Core Wall in Rock-Fill Dam (66787). Ills. 1000 w. E R—Dec. 25, 1915. Trinchera Irrigation District, Colo.

Filtration

Ueber die Filterwirkung von Böden auf kolloidhaltige Wässer (66212 B). Karl Sack. 3500 w. G-I—Nov. 13, 1915. Serial, 1st part. Reprint from treatise, filtering efficiency of soils on colloid-bearing water.

Methods of Washing Slow Sand Filters (66522 N). John Gaub. Ills. 3000 w. A W A—Dec., 1915. Improvements and cost.

Pressure Chamber Equalizes Wash-Water Distribution at Miraflores Filters (66790). George C. Bunker. Ills. 2200 w. E R—Dec. 25, 1915. False bottom with feed pipes to filter bed.

Wooden Filters Prove Economical for Temporary Exposition Water Supply (66609). E. C. Eaton. Ills. 3500 w. E. R—Dec. 18, 1915. Economy by designing tanks and basins as timber flumes.

Good Engineering in Solving the Emergency Water Supply Problem of the Panama-Pacific International Exposition (66091). From a paper by E. C. Eaton. 2500 w. E & C—Dec. 1, 1915. Supply and purification works.

Gravel Wells

Water from Gravel Wells (66524 N). C. W. Wiles. Also discussion. 1000 w. A W A—Dec., 1915. Best method of constructing such wells.

Law

Progress Report of the Special Committee on a National Water Law (66729 D). 1800 w. A S C E—Dec., 1915.

Lime

Columbus Waterworks to Make Its Own Lime (66736). Charles P. Hoover. 1200 w. Mun Jl—Dec. 23, 1915. By burning lime carbonate precipitated in softening plant, sufficient lime obtainable.

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Mains

Laying Submerged Water Mains at Vancouver, B. C. (66831). Ills. 1500 w. E N—Dec. 30, 1915. Flexible joint pipes, 18-in. diameter, laid in 75-ft. of water and rapid current.

Massachusetts

Water-Supplies and Health in Massachusetts (66143). 2100 w. E N—Dec. 2, 1915. Hardness, color; typhoid and general death rates.

Pipe

Results of Questionnaire on Life and Depreciation of Cast Iron Water Pipe in 14 Large American Cities (66501). 2000 w. E & C—Dec. 15, 1915.

Plumbing

Plumbing Code and Control of Plumbers (66536 N). Scotland G. Highland. Ills. Also discussion. 9000 w. A W A—Dec., 1915. Responsibility of waterworks officials.

Purification

Present Status of Disinfection of Water Supplies (66528 N). Francis F. Lougley. Also discussion. 4500 w. A W A—Dec., 1915. From replies to general inquiry.

The Design and Operation of Intermittently Operated Water Purification Plants (66535 N). N. T. Veatch. 1000 w. A W A—Dec., 1915. Particularly when retention period is 4 to 6 hours.

Treatment of Water with Hypochlorite (66554 A). Joseph Race. Read before Soc. of Chem. Ind. (Montreal.) 3000 w. S M C E—Dec. 3, 1915. Effect of temperature; benefits, etc.

Ultra-Violet Ray Sterilization of Water (66625). Ills. 4000 w. Cn E—Dec., 1915. Extracts from report of Ontario Board of Health.

Regis, Germany

Das Wasserwerk des Gemeindeverbandes für Wasserversorgung von Regis und Umgebung (66249 B). Salbach. Ills. 3600 w. E K u B—Nov. 24, 1915. General description of water-supply system for group of towns.

Reservoirs

Reconstruction of a Reservoir at St. Louis, Missouri (66739). Ills. 2600 w. E N—Dec. 23, 1915. Watertight lining and raised wall.

Making Concrete Tight; Tacoma and Seattle Water-Works (66142). C. E. Fowler. Ills. 1100 w. E N—Dec. 2, 1915. Repairing leaks.

Sanitation

Some Considerations in Estimating the Sanitary Quality of Water Supplies (66532 N). W. H. Frost. Also discussion. 7500 w. A W A—Dec., 1915. Mainly discussion of cause of typhoid.

Taps

How to Determine the Size of Tap and Meter (66533 N). Jacob Klein. 700 w. A W A—Dec., 1915. Basis for determining size.

Waterworks

Two Small Waterworks (66520 N). W. L'Estrange Duffin. Ills. 2500 w. I C E I—Dec. 1, 1915. Special features of Passage East, and of Tramore waterworks.

Wells

Artesian Wells and Methods of Pumping Them (66526 N). John D. Kilpatrick. Also discussion. 6000 w. A W A—Dec., 1915. Drilling, construction, pumping.

WATERWAYS AND HARBORS

Black Sea Ports

La Mer Noire et ses ports (66218 B). La Nt—Nov. 20, 1915. Ills. 2500 w. Brief history and description of Black Sea ports.

Buffalo

Buffalo Barge Canal Terminal (66355). Ills. 1000 w. E N—Dec. 9, 1915. Deepening of Erie Basin, and construction of piers.

China

Waterbouwkunde in China (66234 B). F. J. Blom. Ills. 7000 w. Ing—Dec. 4, 1914. River improvement and canal work in China.

Flood Prevention

Progress Report of the Special Committee on Floods and Flood Prevention (66731 D). 6500 w. A S C E—Dec., 1915.

Genoa

Per il porto di Genova (66277 B). L. Coen Gagli. 2700 w. M T—Nov. 20, 1915. Status of new work undertaken for the port of Genoa.

Halifax

Halifax Ocean Terminals (66354). Ills. 3900 w. E N—Dec. 9, 1915. Harbor work by Canadian Government.

Lake Ports

Port Problems of the Great Lakes 66041 A). William George Bruce. 2000 w. M Rv—Dec., 1915. Analysis of factors governing harbor improvements.

Locks

Improving Rapide Plat Canal Lock Entrance (66836). Ills. 4000 w. Cn E—Dec. 30, 1915. Sinking cribs and reconstructing wall, etc., in one of St. Lawrence river canals.

New Orleans

The Port Facilities of New Orleans (66040 A). Ernest M. Loeb. Address at Great Lakes Waterways Conference. 4000 w. M Rv.—Dec., 1915. Summary of methods of administration.

Panama Canal

Economic Aspects of the Panama Canal (66515 N). G. G. Huebner. 5500 w. A E R—Dec., 1915. Effect on routes; commerce; industries.

River Improvement

Improving Navigation on the Upper Mississippi near Le Claire, Iowa (66789). Ills. 1100 w. E R—Dec. 25, 1915. Canal with lock and closing dam.

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The Warrior River—Its Advantages to the Birmingham District (66540). Y. A. Dyer. 2000 w. M Rd—Dec. 16, 1915. Value of improvements on this difficult stream.

Shore Protection

Cause and Prevention of Storm Erosion on Gulf Coast (66141). Gerald O. Casé. Ills. 3500 w. E N—Dec. 2, 1915. Investigation of recent damage.

ELECTRICAL ENGINEERING

COMMUNICATION

Radiotelegraphy

Some Recent Advances in Long Distance Radio-Telegraphy (66551 A). W. C. Ballard. Diagrams. 2000 w. S Jl E —Dec., 1915.

Discussion on "Continuous Waves in Long-Distance Radio-Telegraphy" (Fuller), New York, April 9, 1915 (66662 D). 3000 w. A I E E—Dec., 1915.

Some Considerations on the Marconi High-Power Transmitting Plant (66681 A). N. Skritzky Abstract of paper in *Pro. Elec.-Tech. Inst.*, Petrograd. 3000 w. Eln—Dec. 10, 1915. Experiments and conclusions.

The Signaling Range in Radiotelegraphy (66136). John L. Hogan, Jr. Chart. 700 w. El W—Dec. 4, 1915. Measuring effect of antenna height, current and wave-length upon distance of transmission.

Telephony

Economic, Social and Political Conditions in Europe Which Influence Government Ownership of the Telephone (66752). James P. Duncan. 2500 w. El R S W E—Dec. 25, 1915. Origin and conditions affecting development.

Notes on Telephone Plant Organization (66134). F. Day. 4500 w. El R & W E—Dec. 4, 1915. Basic principles and practical applications.

The Year Nineteen Fifteen in the Telephone Industry (66865). Stanley R. Edwards. 7500 w. Tly—Jan. 1, 1915. Review.

Telephone Transmission and Its Relation to a Plant (66166). H. D. Currier. 2300 w. Tly—Dec. 4, 1915. Importance in telephone business. Considerations involved in study.

The Development of the National Telephone System (66194 A). M. C. Rarty. 1500 w. A S M E Jl—Dec., 1915. Brief review.

Transmission Standards

Tentative Standards of Transmission (66172 A). 4500 w. T E—Dec., 1915. Recommended by Independent Telephone Association of America.

Underground Cables

An Underground Telegraph Cable Installation in Pueblo, Mexico (66628 A). William B. Hale. Ills. 1000 w. El R—Dec. 3, 1915. Details of work.

ELECTRO-CHEMISTRY

Corrosion

The Electrolytic Process for Preventing Corrosion and Scale (66812 A). Ills. 2000 w. C G—Dec. 17, 1915. Cumberland process.

Electrolysis

Effects of Electrolysis on Engineering Structures (66446 B). Albert F. Ganz. 10000 w. S I—Oct., 1915. Effects of stray currents, remedial measures.

Electroplating

A Modern Acid-Dipping, Electroplating and Japanning Plant (66055 A). Horace Niles Trumbull. Ills. 3000 w. G E R—Dec., 1915. Heating and ventilating, medicinal and electrical equipment of hygienic plant.

Copper Cyanide Solutions (66264). W. H. Weber. 1600 w. M I—Dec., 1915. Modern method of preparation.

Storage Batteries

Notes on Storage Batteries (66476 A + D). C. S. McDowell. Curves. 3000 w. A S N E—Nov., 1915. Design and operation.

The Installation and Working of Lead Storage Batteries (66599). R. Rankin. Extract from paper before Assn. of Sup. Elect'ns., London. 2000 w. El R & W E —Dec. 18, 1915. Important points, instructions, etc.

ELECTRO-PHYSICS

Air Conductivity

Discussion on "The Electric Strength of Air—VI" (Whitehead), Deer Park, Md., June 29, 1915 (66668 D). Ills. 3500 w. A I E E—Dec., 1915.

Alternating Current

Fundamental Principles of Alternating Current (66170). F. A. Annett. 2500 w. Pwr—Dec. 7, 1915. Serial, 1st part. Explanation of sine curve.

Corona

The Corona in Air at Continuous Potentials and Pressures Lower Than Atmospheric (66070 A). Donald Mackenzie. Abstract from *Phys. Rev.* 3500 w. Eln—Nov. 19, 1915. Experiments showing difference between positive and negative corona.

Currents

Growth of Current in Circuits of Negative Temperature Coefficient of Resistance (66057 A). F. W. Lyle. 800 w. G E R—Dec., 1915. Applies formula already given and derives new formula.

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Fuses

The Design and Operation of Horn-Gap Fuses (66376). E. A. Dillard. Ills. 2000 w. El W—Dec. 11, 1915. Suitable types for small outdoor substations, behavior and construction.

Magnetism

Magnetic Studies of Mechanical Deformation in Certain Ferromagnetic Metals and Alloys (66412 D). H. Hanemann and Paul D. Merica. Ills. 4000 w. A I M E Bul—Dec., 1915. Investigates the mechanical-magnetic properties.

Oscillations

The Production of Damped Oscillations (66054 A). Leslie O. Heath. Ills. 3000 w. G E R—Dec., 1915. Three most important ways.

Precipitation

Solution of Smoke, Fume and Dust Problems by Electrical Precipitation (66086). Linn Bradley. Address in New York City. 5000 w. M & C E. Dec. 1, 1915.

See also Cottrell Process under MECHANICAL ENGINEERING, *Measurement.*

Rays

A Model X-Ray Dark-Room. (66053 A). Wheeler P. Davey. Ills. 1500 w. G E R—Dec., 1915. Details of small and large rooms.

Reluctance

Discussion on "The Reluctance of Some Irregular Magnetic Fields" (Douglas), Deer Park, Md., June 29, 1915. 66673 D). 2500 w. A I E E—Dec., 1915.

Voltage Waves

The Mathematical Investigation of Voltage Waves Obtained in Testing Iron (66068 A). N. W. McLachlan. 700 w. Eln—Nov. 19, 1915. Critical discussion.

Wave Shapes

The Wave-Shapes Obtaining with Alternating-Current Generators Working Under Steady Short-Circuit Conditions (66851 N). A. E. Clayton. Oscillograms. 20 pp. I E E—Dec., 1915. Detailed study.

GENERATING STATIONS

Alaska-Treadwell

Steam-Electric Power Plant of Alaska Mine (66597). Ills. 3000 w. El R & W E—Dec. 18, 1915. Details of recent oil-burning installation.

Birmingham, Eng.

A Temporary Generating Station at Birmingham (66332 A). Ills. 2000 w. Enr—Nov. 26, 1915. English undertaking.

Detroit

The Connors Creek Plant of the Detroit Edison Company (66566 N). C. F. Hirshfeld. Ills. 25 pp. A S M E—Dec., 1915. Problem due to phenomenal growth.

Economics

Electricity Supply (66438 N). Charles P. Sparks. 8500 w. I E E Jl—Dec., 1915. Inaugural address. Legislation, supply, improvements and progress.

Glasgow

The Generation and Distribution of Electrical Energy in Glasgow (66485 N). W. W. Lackie. 32 pp. I E S S—Nov., 1915.

Hydroelectric

Ten Years of Evolution of Hydro-Electric Units (66651 B). E. B. Ellicott and William B. Jackson. Also discussion. 5000 w. W S E—Oct., 1915. Advance in construction, design and efficiency.

Hydroelectric Station Auxiliary to Steam Plant (66748). Ray K. Holland. Ills. 1500 w. El W—Dec. 25, 1915. The Barton plant near Ann Arbor, Mich. Unusual features.

Hydro-Electric Development in Canadian Prairie Provinces (66399). F. C. Perkins. Ills. 2200 w. P E, C—Dec. 15, 1915. To stimulate industrial growth.

Power Development at Eugenia Falls, Ontario (66123). Ills. 2500 w. Cn E—Dec. 2, 1915. High-head plant on Beaver River.

A New Zealand Hydro-Electric Scheme (66778 A). Ills. 700 w. El R—Dec. 17, 1915. At Ohakune.

Municipal Plant

Regina Municipal Power Plant (66168). A. G. Christie. Ills. 4000 w. Pwr—Dec. 7, 1915. Novel features.

Power Factor

What the Power-Factor Means (66174) A. P. Broadhead. Ills. 1200 w. El A—Dec., 1915. Ways of improving it on a system.

Providence

Modernizing Narragansett Co.'s South Street Station. (66796). Charles H. Bromley. Ills. 3000 w. Pwr—Dec. 28, 1915. Reciprocating-engine station converted into turbo-generating plant without interrupting service.

Substations

The Equipment of a Modern Substation (66173). H. G. Davis. Ills. 4000 w. El A—Dec., 1915. Constructional and control features at Columbus, S. C.

Purchased Power for the New Haven (66619). Ills. 2000 w. El R Jl—Dec. 18, 1915. Details of new substation at West Farms.

West Farms Substation of New Haven Railroad (66603). Ills. 1500 w. El W—Dec. 18, 1915.

Wheeling, W. Va.

Power Station Improvements at Wheeling, W. Va. (66622). J. M. Hopwood. Ills. 2500 w. El T—Dec., 1915. Details of large plant.

West Penn Traction Co.'s Wheeling Power Plant (66428). W. E. Moore. Ills. 2500 w. Pwr—Dec. 14, 1915.

GENERATORS AND MOTORS

Armatures

A Comparison of Motor Armatures of Different Diameters (66312). F. A. Rew. 1200 w. El Jl—Dec., 1915. Design.

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Carbon Brushes

Discussion on "Some Troubles Encountered in the Operation of Carbon Brushes on Direct-Current Generators and Motors" (Martindale), Cleveland, Ohio, March 19, 1915 (66665 D) 4500 w. A I E E—Dec., 1915.

Control

The Principles and Systems of Electric Motor Control (66661 D). C. D. Knight. Ills. 3500 w. A I E E—Dec., 1915. Types of resistance, forms of magnetic control.

Heating

Graphisches Verfahren zur Vorausbestimmung der Erwärmung von Bahnmotoren (66210). H. Engel. Ills. 2000 w. E K u B—Nov. 14, 1915. Graphic calculations to determine heating to be expected in railway motors.

High-Speed Generators

Some Difficulties of Design of High-Speed Generators (66439 N). A. B. Field. Ills. 8000 w. I E E Jl—1915. Specific examples.

Insulation

Notes on Industrial Motor Insulation (66310). J. L. Rylander. 2000 w. El Jl—Dec., 1915. Points requiring attention.

Motor Installation

Installation von Elektromotoren (66256 B). E. Adler. 3500 w. E u M—Nov. 28, 1915. Fields of different types of motors with hints as to installation.

Railway Motors

Luftgekühlte Strassenbahnmotoren der AEG (66211 B). Leonhard Adler. Ills. 2800 w. E K u B—Nov 14, 1915. Methods of air cooling on AEG street-car motors.

Rotary Converters

The Starting of Rotary Converters (66069 A). W. Linke. Abstract from *Elektro Zeit.* 2500 w. Eln—Nov. 19, 1915. Methods in practical working of rotaries.

Armature Copper Losses in Rotary Converters and Double-Current Generators (66444 N). Laurence H. A. Carr. 1500 w. I E E—Nov. 29, 1915. Calculations.

Three-Phase Generators

Three-Phase Generators for the Rjukanfos Power Station (66680 A). Ills. 2000 w. Eln—Dec. 10, 1915. Largest built for direct coupling to water-turbines.

ILLUMINATION

Automobile Lighting

See Lighting under MECHANICAL ENGINEERING, *Automobiles.*

Candlepower

The Candle-Power and Beam of a Paraffine Lamp (66626 A). D. H. Ogley. Ills. 1800 w. Acr—Dec. 4, 1915. Serial, 1st part. Results of experiments and measurements.

Color Mixture

The Transformation of Color-Mixture Equations from One System to Another (66519 B). Herbert E. Ives. 6500 w. F I—Dec., 1915. Data.

Good Lighting

The Fundamental Principles of Good Lighting (66333). Dr. P. G. Nutting. 6500 w. G A—Dec. 15, 1915. Outlines the principles upon which the theory of good lighting is based.

Hefner Lamps

The Dependence of the Light of the Hefner Lamp on Atmospheric Conditions—More Especially Atmospheric Pressure (66065 A). Dr. E. Ott. Ills. 3500 w. Eln—Nov. 19, 1915. Determined by measurements in closed receiver.

Incandescent Arc

A New High-Efficiency Incandescent Lamp (66440 N). E. A. Gimingham and S. R. Mullard. Ills. 2500 w. I E E—Nov. 29, 1915. Small arc in gas-filled bulb.

Legislation

Establishing a Basis for Laws on Lighting (66750). C. E. Clewell. 2000 w. El W—Dec. 25, 1915. British report and recommendations reviewed.

Searchlights

See same heading under MARINE AND NAVAL ENGINEERING.

Streets

Discussion on "The Effective Illumination of Streets" (Millar) Deer Park, Md., June 30, 1915 (66670 D). 5500 w. A I E E—Dec., 1915.

Uniformity

L'influenza della forma del solido fotometrico dell' altezza e della distanza delle lampade sul grado di uniformita della illuminazione (66209 B). Guido Peri. Ills. 2500 w. Ind—Nov. 7, 1915. Uniformity of illumination from a lamp as affected by the form of the photometric body, its height and distance from lamp.

MEASUREMENT

Current

Simple Thermal Instruments for the Measurement of Current (66066 A). W. H. Eccles and A. J. Makower. 800 w. Eln—Nov. 19, 1915. High frequency currents of small magnitude.

Damped Oscillations

A Mode of Studying Damped Oscillations by the Aid of Shrinking Vectors (66442 N). David Robertson. 5000 w. I E E—Nov. 29, 1915. Equations.

Earth Plates

The Calculation of the Effective Resistance of Earth Plate (66683 A). G. W. O. Howe. 2500 w. Eln—Dec. 10, 1915. Equivalent length calculated without measurement of specific resistance.

High Tension

Variations in the Wave-Shape in High-Tension Testing Installations (66807 A). Dr. Gustav Benischke. Abstract from *Electro. Zeit.* Diagrams. 1500 w. Eln—Dec. 17, 1915. A study.

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Instrument Transformers

Errors Due to the Use of Instrument Transformers (66377). R. H. Chadwick. 1200 w. El W—Dec. 1, 1915. Effect of angle of phase displacement.

Magnetism

The Magnetic Testing of Bars of Straight or Curved Form (66443 N). Albert Campbell and D. W. Dye. Ills. 6000 w. I E E—Nov. 29, 1915. Different methods.

Meters

Watthour Meters (66047). O. H. Henschel. Ills. 1500 w. P E, C—Nov. 15, 1915. Serial, 1st part. Installation, care, adjustment and types.

Oscillograms

The Amplitude and Phase of the Higher Harmonics in Oscillograms (66441 N). G. W. O. Howe. 2500 w. I E E—Nov. 29, 1915. Investigation.

Stoneware

Elasticity and Strength of Stoneware and Porcelain (66570 N). James E. Boyd. Ills. 3500 w. A S M E—Dec., 1915. Investigation to obtain information needed in designing insulators.

Wave-Lengths

An Abac for the Calculation of Wave-Lengths (66806 A). W. Eccles. 1000 w. Eln—Dec. 17, 1915. Oval abac; examples.

POWER APPLICATIONS

Agriculture

Electricity in Agriculture: Its National Aspects (66630 A). 2000 w. El R —Dec. 3, 1915. Views of different writers.

See also Farm Tractors under MECHANICAL ENGINEERING, *Combustion Motors.*

Electro-Metallurgy

Electrometallurgical Industries as Possible Consumers of Electric Power (66424 D). 2500 w. A I M E Bul—Dec., 1915. Discussion of paper by Dorsey A. Lyon and Robert M. Keeney.

Enameling

Electrically Heated Enameling Ovens (66058 A). C. W. Bartlett. Ills. 2500 w. G E R—Dtc., 1915. Types.

Foundries

Discussion on "Industrial Control in the Foundry" (McLain), Pittsburgh, Pa., April 15, 1915 (66667 D). 6500 w. A I E E—Dec., 1915.

Freight Terminals

The Possibilities Open to the Central Station in Solving the Freight Terminal Problem (66060 A). Jas. A. Jackson. 1500 w. G E R—Dec., 1915. Adaptation of the electric motor.

Future Development

Future Possibilities of Electricity (66114). Carl Hering. 2500 w. S A—Dec. 4, 1915. Applications awaiting development.

Heating

Electric Heating and Schoop's Metal Squirting Process (66679 A). Dr. Lach. Abstract from *Elektro. Zeit.* 1000 w. Eln—Dec. 10, 1915. Details of process.

Hoisting

Discussion on "Control of Direct-Current Hoists in Iron and Steel Mills" (Stoltz and Lum), and "Direct Current Control for Hoisting Equipment in Industrial Plants (Snyder), Pittsburgh, Pa., April 16, 1915 (66664 D). 10000 w. A I E E—Dec., 1915.

Ice Harvesting

Electricity in Ice Harvesting (66130). Ills. 1500 w. El R & W E—Dec. 4, 1915. Installation in New England.

Industrial

Discussion on "Field of Motor Application" (Rushmore), and "Electricity in Grain Elevators" (Stafford), Deer Park, Md., June 29, 1915. (66669 D). 22500 w. A I E E—Dec., 1915.

Machine Tools

Electric Operation and Automatic Electric Control for Machine Tools (66569 N). L. C. Brooks. Ills. 5000 w. A S M E—Dec., 1915. Advantages; starters; important factors.

Printing

The Electric Motor in the Printing Industry (66059 A). W. C. Yates. Ills. 4500 w. G E R—Dec., 1915. Advantages.

Pump Works

Electricity in Pump Manufacture (66374). Ills. 2000 w. El R & W E—Dec. 11, 1915. Data on two typical installations.

Schools

Electric Service for a City High School (66133). C. L. Vestal. Ills. 1200 w. El R & W E—Dec. 4, 1915. Carl Schurz school, Chicago.

Soap Manufacture

Electricity in Soap Manufacture (66751). Ills. 2000 w. El R & W E—Dec. 25, 1915. Processes and power applications.

Textile Mills

Relative Value of Private and Purchased Electric Power for Textile Mills (66579 N). Frank W. Reynolds and Dan Adams. 18 pp. A S M E—Dec., 1915. Analysis and conclusions.

TRANSFORMERS

Form Factor

Discussion on "Form Factor and its Significance" (Bedell, Bown, Pidgeon), "Distortion Factors" (Bedell, Bown, Swisher), and "An Analytical and Graphical Solution for Non-Sinusoidal Alternating Currents" (Mizushi), Deer Park, Md., June 29, 1915 (66674 D). Ills. 12000 w. A I E E—Dec., 1915.

Losses

Wirbelstromverluste im Transformatorenkupfer (66255 B). M. Vidmar. Ills. 2800 w. E u M—Nov. 28, 1915. Serial, 1st part. Analysis of losses by eddy currents in transformer copper.

Manufacture

Willem Smit & Co.'s Transformatorenfabriek te Nijmegen (66200 B). Ths. Rosskopf. Ills. 2000 w. Ing—Nov. 13, 1915. Smit transformer works.

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Stresses

Mechanical Stresses in Transformers (66309). J. F. Peters. Ills. 2000 w. El Jl—Dec., 1915. Caused by stray magnetic fields that pass through windings.

TRANSMISSION AND DISTRIBUTION

Cables

Cable Suitable for Industrial Plant Subway System (66749). H. D. Austin. 1200 w. El W—Dec. 25, 1915. Comparison of rubber, cambric and paper insulation.

Electric Waves

Theory of Electric Waves in Transmission Lines (66061 A). J. M. Weed. 3000 w. G E R—Dec., 1915. Serial, 1st part. Theoretical study.

Grounding

Desirability and Method of Connecting Low-Voltage Secondary Electrical Circuits to Water Pipes—Effect on the Pipe System (66820). Burton McCollum and O. S. Peters. 6500 w. E & C—Dec. 29, 1915. Dangers and protection, earth connections, electrolysis, etc.

High Pressure

The Design of High-Pressure Distribution Systems (66676 N). J. R. Beard. Ills. 4000 w. I E E Jl—Dec., 1915. Problems and practice.

New Haven R.R.

Feeding Heavy Single-Phase Load from Three-Phase Units (66375). Ills. 1500 w. El W—Dec. 11, 1915. Serial, 1st part. United Electric Light & Power Co., N. Y. City, to serve N. Y., N. H. & H. R. R.

Telephones

How a Transmission Company Prevented Telephone Troubles (66379). F. Maury Gillespie. 1000 w. El W—Dec. 11, 1915. Arrangements for overcoming difficulties.

Testing

Testing for Grounds and Insulation Resistance (66132). Diagrams. 2800 w. El R & W E—Dec. 4, 1915. Types of detectors, methods, and examples.

Tower Lines

Protecting Tower Lines from Sleet (66604). Forster Holmgren. 800 w. El W—Dec. 18, 1915. Recommendations for Sweden.

Towers

Discussion on "Foundations for Transmission Line Towers and Tower Erection" (Walls, Leeper, Michell, Downing, Connery), and "Four Years' Operating Experience on a High Tension Transmission Line" (Bang), Deer Park, Md., June 29, 1915 (66675 D). Ills. 3500 w. A I E E —Dec., 1915.

Underground System

An Underground System for an Industrial Plant (66137). H. D. Austin. Ills. 2000 w. El W—Dec. 4, 1915. For distribution to group of factory buildings.

MISCELLANY

Inspection Records

System of Keeping Records of Current Work in Electrical Inspection Department (66600). 3200 w. El R & W E—Dec. 18, 1915. Serial, 1st part. Methods and forms.

INDUSTRIAL ECONOMY

EDUCATION

Co-Operative Schools

Co-operative Technical Schools Meet Present Needs (66139). Fred E. Ayer. 1800 w. E N—Dec. 2, 1915. Benefits of alternating school and practical work.

Employees

Educating Workers for Higher Efficiency (66827 A). F. B. & L. M. Gilbreth. Ills. 2800 w. I A—Dec. 30, 1915. Methods.

Engineering

Engineering-Education Faults (66740). W. M. Wilson. 1800 w. E N —Dec. 23, 1915. Menace of over-specialization.

Broader Training for the Engineer (66445 B). Alexander C. Humphreys. First of two lectures at Brown University. 7500 w. S I—Oct., 1915. Responsibility as citizen; preparation needed.

Street-Railway Employees

Motive Power Department's Part (66237). F. H. Miller. Ills. 2500 w. Rose Tech—Dec., 1915. Instruction of Louisville motormen.

FINANCE AND COSTS

Cost Keeping

Methods and Results of Cost Recording on Pavement Work at St. Paul, Minn. (66343). 3000 w. E & C—Dec. 8, 1915. Extract from a discussion by J. E. Carroll, before Minnesota Surveyors & Engrs' Soc.

Construction Cost Keeping by the Mason City, Iowa, Water Department (66344). W. A. Judd. 1200 w. E & C—Dec. 8, 1915. Details.

Depreciation

Depreciation of Property (66052 A). W. B. Curtiss. 7500 w. G E R—Dec., 1915. Serial, 1st part. First of series on accounting and finance.

Expense Distribution

Overhead Expense Distribution (66287 A). N. T. Ficker. 3500 w. E M—Jan., 1916. Eighth and last article of series. Way to remedy defects of machine-unit system by aid of "current variation" ratios which adjust manufacturing costs in periods of depression.

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Mining

European Mining Finance (66162). J. L. Gallard. Read at Int. Engng. Cong. 5000 w. C M Jl—Dec. 1, 1915. Importance; requirements; methods.

Railway Valuation

Bay State Street Railway Valuation (66159). 3000 w. El R Jl—Dec. 4, 1915. Methods and results of 18 months investigation in connection with fare case.

Chicago & Northwestern Ry. Valuation Methods (66547). Ills. 3000 w. E N—Dec. 16, 1915. Rules and instructions to engineers.

Public-Utility Valuation

Some Intangible Values in Water Systems, with Special Reference to the Water Right (66742). Otto von Geldern. From a paper read in San Francisco. 4000 w. E & C—Dec. 22, 1915. Valuation of water-works.

MANAGEMENT

Consent

The Progressive Relation between Efficiency and Consent (66266 N). Robert G. Valentine. 3500 w. S P S M Bul—Nov., 1915. Dangers in application of Taylor system.

Ford Shops

The New Ford Line-Up (66288 A). Fay L. Faurote. Ills. 2000 w. E M—Jan., 1916. Changes in personnel of the Ford Motor Co.

Personal Relationship

Personal Relationship as a Basis of Scientific Management (66265 N). Richard A. Feiss. 20000 w. S P S M Bul—Nov., 1915. Remarkable success of Joseph & Feiss Co.

Production

Production and Sales (66291 A). Henry L. Gantt. 3500 w. E M—Jan., 1916. Refutation of theory that high selling prices are necessary to large profits.

Purchasing

Anticipating Buying Emergencies (66097 A). H. A. Russell. 2500 w. I A—Dec. 2, 1915. Information needed to guard against shortage of material.

Trained Buyers Save Big Sums in City Purchases of Supplies and Equipment (66153). Extracts from address by Fowler S. Smith at City Mgrs' convention. 1800 w. E R—Dec. 4, 1915. Economies possible under city manager.

Scientific Management

Exact Control of Manufacture in Practice (66544 A). George D. Babcock. Address before the Univ. Ind. Soc. 4000 w. I A—Dec. 16, 1915. Results of four years experience.

Stock Keeping

Stock Keeping in Adding Machine Factory (66337 A). F. L. Prentiss. Ills. 2200 w. I A—Dec. 9, 1915. Handling and routing.

Handling Stores According to the Cash-Control Idea (66131). Wilfred G. Astle. Ills. 2500 w. El R & W E—Dec. 4, 1915.

REGULATION

Foundries

Pennsylvania Control of Foundry Operation (66305). 3300 w. Fnd—Dec., 1915. Summary of regulations governing casting plants.

I. C. C.

Annual Report of the Interstate Commerce Commission (66581). 5500 w. R A G—Dec. 17, 1915. Condensed abstract. Recommends enlargement of membership and extension of powers to meet increased demands.

Public Utilities

Franchises of Public Utilities as They Were and as They Are (66534 N). Henry C. Hodgkins. 5500 w. A W A—Dec., 1915. Utilities ordinarily within limits of municipality, and their adequate regulation.

Telephones

Service Cost of Telephones Described by Commission (66618). 5000 w. Tly—Dec. 18, 1915. Serial, 1st part. Decision of Wisconsin R. R. Commission.

WELFARE AND SAFETY

Accident Prevention

Industrial Safety and Principles of Management (66190 A). W. P. Barba. 5000 w. A S M E Jl—Dec., 1915. Problems and their solution.

Air Compressors

Safeguarding Air Compressors (66252 N). 4 pp. T S—Dec., 1915. Hazards and protection against them.

Automobiles

The Contributions of the Automobile Engineer to the Movement for Public Safety (66363 B). K. W. Zimmerschied. 2500 w. S A E Bul—Nov., 1915. Aiming at safety in traffic.

Blast Furnaces

Sicherheitsvorkehrungen bei Hochofenschrägaufzügen (66225 B). Rudolf Brennecke. Ills. 2000 w. St u E—Nov. 18, 1915. Serial, 1st part. Safety devices around the blast-furnace hoist.

Cripples

Motion Study for the Crippled Soldier (66186 A). Frank B. Gilbreth. Ills. Discussion. 4500 w. A S M E Jl—Dec., 1915. Investigations of lines of work open to various types of cripples.

Der heutige Stand der Herstellung künstlicher Gliedmassen (66227 B). F. Tiessen. Ills. 5000 w. Z V d I—Nov. 20, 1915. Present practice in the making of artificial limbs.

Employees' Organization

Mutual Beneficial Association on the Pennsylvania (66368). N. F. Dougherty. 3000 w. R A G—Dec. 10, 1915. Organization of employees without walking delegates or strike-clause in by-laws.

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Grinding

Safety Code for the Use and Care of Abrasive Wheels (66572 N). 2500 w. A S M E—Dec., 1915. Code submitted for consideration of Society.

Safety Standardization

Standardization of Safety Principles (66576 N). Carl M. Hansen. Ills. 3000 w. A S M E—Dec., 1915. Discusses requisites.

Street Railways

Welfare Work (66050 A). Jesse W. Lilienthal. 5500 w. G E R—Dec., 1915. Address before Am. Elec. Ry. Assn. Code of commandments.

Water Tanks

See same heading under CIVIL ENGINEERING, *Construction.*

Workmen's Compensation

Workmens Compensation (66850 A). W. S. Diggs. 22 pp. R C P—Nov. 22, 1915. From standpoint of insurance underwriters. Also discussion.

Workmen's Compensation Law and Mine Safety (66862). H. M. Wilson. 5500 w. Cl A—Jan. 1, 1916. Methods of determining rates.

MISCELLANY

Bureau of Standards

The Work of the National Bureau of Standards (66262 A). S. W. Stratton. 49 pp. E C D Pro—Oct., 1915. General description with discussion.

Exhibitions

The Smithfield Club Show (66693 A). Ills. 3500 w. Enr—Dec. 10, 1915. Serial. 1st part. Describes exhibits.

Load Factor

A Third Factor in the Variation of Productivity: the Load Factor (66514 N). G. P. Watkins. 13500 w. A E R—Dec., 1915. Place of concept in economics.

Merchant Marine

The American Merchant Marine—Re-Creation of a Vast New Industry (66283 A). John R. Dunlap. 1500 w. E M—Jan., 1916. Shipbuilding progress in America.

The Pressing Need for a Merchant Marine (66284 A). Stuart G. Gibboney. 2000 w. E M—Jan., 1916. Relief measures needed for American exporters.

Presidential Addresses

Annual Address by the President of the American Foundrymen's Association (66717 N). R. A. Bull. 4500 w. A F A—Oct., 1915. Work of year and advances in practice.

Presidential Address to the North-East Coast Institution of Engineers and Shipbuilders (66487 N). Herbert B. Rowell. 6000 w. N E C I E S—Nov., 1915. Aeroplanes, warships, industry. education, etc.

Selling Methods

Selling Machinery by Motion Pictures (66285 A). John M. Torr. Ills. 3500 w. E M—Jan., 1916. Advantages from use of industrial films.

Technical Compounds

Some Notes on the Writing of Compound Technical Terms (66823). 3000 w. E & C—Dec. 29, 1915. Critical discussion of American practice.

Trade

Credit and the Future of American Foreign Trade (66434 N). V. Gonzales. 9500 w. Natl Assn Mfrs—Dec. 6, 1915. Study of economic problems.

The International Situation and Future Trade Relations (66433 N). John Bassett Moore. 4000 w. Natl Assn Mfrs—Dec. 6, 1915. Discussion of commercial treaties.

MARINE AND NAVAL ENGINEERING

Bulkheads

Schottkurven (66245 B). W. Abel. Ills. 2200 w. Sch—Nov. 24, 1915. Serial, 1st part. Design and calculation of bulkheads.

Design

Ermittlung der Spantenskala auf geometrischem Wege (66201 B). W. Engelhardt. Ills. 1500 w. Sch—Nov. 10, 1915. Geometrical processes for the design of a ship's framework; with tables and plates.

The Time-Element and Related Matters in Some Ship Calculation (66695 N). J. J. Welch. Curves. 4000 w. N E I E S—Dec. 17, 1915. In certain problems factors may be introduced which render results unrealizable in practice, as shown by examples.

Destroyers

U. S. S. Cushing (66473 A + D). Ormond L. Cox. Ills. 2500 w. A S N E—Nov., 1915. General description and trials of United States torpedo-boat destroyer.

Description and Trials of U. S. S. Torpedo-Boat Destroyer O'Brien (66475 A + D). W. F. Cochrane. Ills. 3000 w. A S N E—Nov., 1915. Formal and technical presentation of results.

Description and Trials of U. S. Torpedo-Boat Destroyer Winslow (66481 A + D). W. F. Cochrane. 1200 w. A S N E—Nov., 1915.

Dry Docks

Pearl Harbor Dry Dock (66722 D). 1200 w. A S C E—Dec., 1915. Continued discussion of H. R. Stanford's paper.

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Evaporators

Salt-Water Evaporators (66480 A + D). William L. De Baufre. Curves. 3000 w. A S N E—Nov., 1915. Calculation of blow-down loss, heat balance, etc.

Ferry Boat

A Double-Ended Motor Ferry Boat (66042 A). Charles J. Belden. Ills. 1000 w. M Rv—Dec., 1915. Steel vessel with gasoline engine.

Gunboats

Description and Trials of U. S. S. Sacramento (Gunboat No. 19) (66479 A + D). W. F. Sicard. Ills. 6500 w. A S N E—Nov., 1915.

Lubrication

Practical Lubrication (66472 A + D). G. S. Bryan. 4000 w. A S N E—Nov., 1915. Information useful to engineers.

Mine Sweeping

The Development of the Science of Mine-Sweeping (66701 N). Translated from *Nauticus* for 1914. Ills. 7000 w. R U S I—Nov., 1915.

Model Experiments

Notes on Model Experiments (66361 N). G. S. Baker. Ills. 20 pp. N E C I E S—Nov. 26, 1915. Work in William Froude National Tank.

Motor Ships

Twin-Screw Motor Tank Vessel Hera (66080 A). Ills. 800 w. Enr—Nov. 19, 1915. Details of vessel and machinery.

Oil Burning

Oil Burning (66482 A + D). A. M. R. Allen. 4000 w. A S N E—Nov., 1915. Proper operation; training of firemen.

Propellers

The Mystery of the Screw Propeller (66470 A + D). C. W. Dyson. Charts. 50 pp. A S N E—Nov., 1915. Partial solution.

The Screw Propeller (66299 A). Sir Archibald Denny. Read before the Inst. of Marine Engrs. 4500 w. Mch E—Dec. 17, 1915. Experimental study.

Propulsion

Some Alternative Types of Propelling Machinery for a 19¼-Knot Steamer (66486 N). James Dornan. Tables and Drawings. 20 pp. I E S S—Nov., 1915. Weights, coal consumption, and space necessary.

Some Alternative Types of Propelling Machinery for a 19¼-Knot Steamer (66859 N). 7500 w. I E S S—Dec., 1915. Discussion of James Dornan's paper.

Description of Main Propelling Machinery for the U. S. S. Maumee (66471 A + D). C. W. Nimitz. Ills. 28 pp. A S N E—Nov., 1915. Ship for fuel and supplies, propelled by Diesel engines.

Pumps

Notes on Pumps (66483 A + D). S. M. Robinson. 7500 w. A S N E—Nov., 1915. Information obtained from officers.

Salvaging

The Refloating of the R. N. San Giorgio (Nov. 21-Dec. 10, 1913) (66451 B). Ills. 11000 w. U S N I—Nov.-Dec., 1915. Extracts from report of Rear-Admiral Umberto Cagni.

Salvage Operations on Submarine F-4 (66449 B). J. A. Furer. Ills. 10000 w. U S N I—Nov.-Dec., 1915. Detailed account.

Searchlights

Discussion on "Searchlights" (McDowell), New York, February 18, 1915 (66666 D). 4000 w. A I E E—Dec., 1915.

Steamships

Doppelschraubendampfer "Jean Pieterszcon Coen" (66202 B). Ills. 500 w. Sch—Nov. 10, 1915. Passenger steamer recently launched for the Dutch-Java trade.

Steel Boats

A New Method of Bending Plates for Eliminating Riveted Joints in Light Steel-Boat Construction (66860 N). James Anderson. Ills. 2000 w. I E S S—Dec., 1915.

Submarines

Present Condition of the Submarine (66636 A). Max A. Laubeuf. Abstract of paper before the Int. Cong. Diagrams. 3000 w. Eng—Dec. 3, 1915. Types, construction and present tendencies.

Submarine Tender

Description and Trials of U. S. S. Fulton (Submarine Tender No. 1) (66477 A + D). C. N. Hinkamp. Diagrams. 2500 w. A S N E—Nov., 1915.

Turbines

Turbine Machinery of the S. S. "Bingera" (66813 A). Ills. 700 w. Eng—Dec. 17, 1915. Replacement by triple-expansion reciprocating engines.

U. S. Navy

Engineering in the Navy (66051 A). W. L. R. Emmet. 1300 w. G E R—Dec., 1915. Difficulties encountered and improvements needed.

MECHANICAL ENGINEERING

AERONAUTICS

Aero Engines

Should Aero Engines be Air or Water-Cooled? (66677 A). 3500 w. Acr—Dec. 11, 1915. Favoring water-cooled.

Military Aeroplanes

The New Sturtevant Battleplane (66261 B). Ills. 700 w. A A—Dec. 27, 1915. Brief description of engine and construction features.

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Signaling

Communicating with Aircraft (66117). From *London Times Engng. Sup.* 1200 w. S A S—Dec. 4, 1915. Methods of signaling.

AUTOMOBILES

Carbureters

Carbureters Classified (66539). Ills. 4500 w. Aut—Dec. 16, 1915. Suggests five divisions.

Chain Drives

Laying Out Chain Camshaft Drives (66122). F. L. Morse. Ills. 4500 w. Aut—Dec. 2, 1915. Principles and problems.

Crankshafts

Design of Crankshafts for High-Speed Engines (66164). P. M. Heldt. Ills. 2500 w. H A—Dec. 1, 1915. Serial, 1st part. Equations for proportions of types.

Design

The Automobiles of 1916 (66840 A). Ills. 28 pp. Aut—Dec. 30, 1915.

1916 Passenger Automobiles Listed with Their Technical Specifications (66841 A). 8 pp. 108 makes of cars and 176 chassis models.

Engines

Power Plants Are Simpler (66839 A). 3000 w. Aut—Dec. 30, 1915. Review of the year's progress.

Twelve-Cylinder Engines (66364 B). J. G. Vincent. Ills. Also discussion. 5000 w. S A E Bul—Nov., 1915. Serial, 1st part. Advantages, design and construction.

Farm Tractors

Revue de culture mécanique (66217 C + D). Max Ringelmann. Ills. 45 pp. S E I N Bul—Sept.-Oct., 1915. Review of progress in adaptation of electric and combustion motors to plowing, etc. Exhibitions, tests, accessory apparatus.

Culture mécanique et tracteurs agricoles (66236 B). Ills. 2500 w. G C—Dec. 4, 1915. Serial, 1st part. Review of subject of mechanical tractors for plows, etc.

Some French Power Ploughing Trials (66835 A). 3000 w. Enr—Dec. 17, 1915. Serial, 1st part. Trials under Government auspices.

Motor Implements at the Yorkshire Agricultural Society's Trials (66076 A). Ills. 2500 w. Eng—Nov. 19, 1915. Describes exhibits.

Front Drive

The Laviolette Front Wheel Drive (66063 A). Ills. 2000 w. Acr—Nov. 20, 1915. Belgian design with worm transmission.

Ignition

Ignition Systems Improved in Detail (66347). J. Edward Schipper. Ills. 7000 w. Aut—Dec. 9, 1915. Progress during past year.

Magneto versus Battery Ignition (66857 N). Francis R. Hoyt. Ills. 2500 w. S A E—Jan., 1916. Comparative analysis.

Battery versus Magneto Ignition (66855 N). Frank Conrad. 1500 w. S A E—Jan., 1916. Distinctions between systems.

Notes on Battery Ignition (66856 N). Alexander Churchward. Ills. Oscillograms. 500 w. S A E—Jan., 1916. Types. Troubles of starting.

Jet Control

The Berdea Jet Control (66627 A). Ills. 1400 w. Acr—Dec. 4, 1915. Method of regulating mixture from driver's seat.

Kitchen Cars

Der Küchenwagenzug des deutschen Kaisers (66213 B). Ills. 1200 w. Au-R—Oct., 1915. General description of field-cooking automobile for Kaiser.

Lighting

Lighting Systems Simplified (66121). A. Ludlow Clayden. Ills. 5000 w. Aut—Dec. 2, 1915. Improvements for 1916.

Electric Bulbs for Automobiles (66854 N). Henry Schroeder. Ills. 2500 w. S A E—Jan., 1916. Manufacture and characteristics of tungsten filaments and lamps.

Lubrication

Irish Car is Self-Lubricating (66348). Ills. 2500 w. Aut—Dec. 9, 1915. British car with every portion of chassis automatically lubricated.

Why Crawl to Oil? (66064 A). Ills. 1000 w. Acr—Nov. 20, 1915. Lubrication of Guy chassis.

Motor Trucks

Motor Trucks After the War (66290 A). Rollin W. Hutchinson, Jr. Ills. 5500 w. E M—Jan., 1916. Effect will be to increase demand, lower prices, improve design and stimulate the industry in every way.

Motor Efficiency Proven by Macy & Co. Investigation (66502 A). 9000 w. C V—Dec. 15, 1915. Study of delivery system made by Research Division of Mass. Inst. of Technology.

Keep the Wheels Turning to Make Motor Trucks Profitable for Contractors (66383). Ills. 1800 w. E R—Dec. 11, 1915. Suggestions for the use, operation and maintenance.

Making Motor Truck Pay on Short Hauls (66386). Ills. 2000 w. E R—Dec. 11, 1915. Efficiency test.

Progress

Transcendancy (66838 A). 3500 w. Aut—Dec. 30, 1915. Factors which have brought the remarkable progress during past year.

Springs

Fifth Report of the Springs Division (66853 N). Ills. 1500 w. S A E—Jan., 1916. Proposed specifications.

Tractors

Tractors and Trailers in Municipal Work (66349). Ills. 2200 w. Mun Jl—Dec. 9, 1915. Examples of use and statement of advantages.

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COMBUSTION MOTORS

Gasoline

A Rational Basis for Motor Gasoline Specifications (66405 A). Paul W. Prutzman. Abstract of paper before Am. Petroleum Soc. 1200 w. W E—Dec., 1915. Summary of conditions to be satisfied.

Gas Producers

Gas Producers with By-product Recovery (66559 N). Arthur H. Lymn. Ills. 6000 w. A S M E—Dec., 1915. Historical résumé.

The Bituminous Coal Producer Plant: The Suction Plant (66324 A). E. M. Rose. Ills. 1500 w. Mch W—Nov. 26, 1915. Tests and results.

Oil Engines

Development of Oil Engines (66192 A). 5500 w. A S M E Jl—Dec., 1915. Discussion of papers by Adams and Goldingham.

Oil Engine Vaporizer Proportions (66564 N). Louis Illmer. Ills. 20 pp. A S M E—Dec., 1915. Research on hot bulbs and high-compression vaporizers.

Power Plants

An Investigation of the Gas-Producer Power Plants in New York City and Vicinity (66189 A). C. M. Ripley. Also discussion. 10000 w. A S M E Jl—Dec., 1915. Size, age, performance, costs.

Sommerfeld Gas-Engine Plant (66640). W. O. Rogers. Ills. 1000 w. Pwr—Dec. 21, 1915. In Pittsburgh.

Waste Heat

Ueber die Verwertung der Abwärme von Verbrennungsmaschinen in Turbinen (66258 B). Wilhelm Gentsch. Ills. 2000 w. Z g T—Nov. 30. Serial, 1st part. How turbines may utilize waste heat from combustion engines.

HEATING AND COOLING

Churches

The Heating and Ventilating of Churches (66819 B). Harold L. Alt. Ills. 3500 w. Bkbld—Dec., 1915. Practical systems and their installation.

Combination Plant

A Large Combination Steam and Forced Hot Water Heating Plant (66510). Ills. 1500 w. H & V M—Dec., 1915. N. Y. State Reformatory for Women, Bedford Hills, N. Y.

Heating Coils

Notes on the Use of Heating Coils (66508). T. W. Reynolds. 2000 w. H & V M—Dec., 1915. Examples of proper and improper design.

Hot-Water Heating

Heating by Forced Circulation of Hot Water in Textile Mills (66577 N). Albert Greene Duncan. Ills. 20 pp. A S M E—Dec., 1915. Heating by exhaust steam.

Ice Making

Raw Water Ice (66199 A). H. D. Pownall. Ills. 3300 w. I & R—Dec., 1915. Systems in use, particularly Arctic-Pownall.

Ice Plants

Management and Operation of Ice Plants (66195 A). Charles F. Rantz. 2500 w. I & R—Dec., 1915. Suggestions for economy.

The Direct Connected Oil Engine Driven Ice Mfg. Plant (66198 A). William T. Price. Ills. 3000 w. I & R—Dec., 1915. Advantages, types, etc.

The High Compression Oil Engine for Ice Manufacturing (66196 A). Hollis Paine Porter. 1800 w. I & R—Dec., 1915. Designs, economy, cost.

Radiation

New Radiation Coefficients (66509). 1200 w. H & V M—Dec., 1915. Based on tests by heating department of University of London.

Refrigeration

Foreign Gases and Solids in the Absorption Plant (66799). H. G. Gibson. 1000 w. Pwr—Dec. 28, 1915. How air and gases from decomposed ammonia show their presence.

Ammonia in Absorption Ice Machines (66197 A). Dr. F. W. Frerichs. 2000 w. I & R—Dec., 1915. Suggestions for successful operation.

Ventilation

Ozone for Ventilation (66463). Ills. 2500 w. M & C E—Dec. 15, 1915. Report of test of Westinghouse air ozonizer, with experiments by Sheppard T. Powell.

HYDRAULIC MACHINERY

Centrifugal Pumps

Shop and Acceptance Tests of 30,000,000-Gal. Pump (66429). Ills. 2000 w. Pwr—Dec. 14, 1915. Two tests of turbine-driven centrifugal pump.

Discharge Accelerator

Unique Hydraulic Power Plant at the Henry Ford Farms (66558 N). Mark A. Replogle. Ills. 2200 w. A S M E—Dec., 1915. Compensation for high water.

Marine Pumps

See Pumps under MARINE AND NAVAL ENGINEERING.

Pumping Units

Pointers for Comparing Types of Pumping Units (66829). George M. Peek. 1200 w. E N—Dec. 30, 1915. Comparison of two St. Louis pumps.

MACHINE ELEMENTS AND DESIGN

Ball Bearings

Design and Application of Ball Bearings (66362 N). H. J. Moysey. Ills. 19 pp. M A E—Nov. 27, 1915. Reviews history and gives details of applications.

Springs

Spring Making and Repairing (66270 N). 17 pp. Int R R Mas Blacksmiths Assn Pro—Aug., 1915. Committee report, series of short letters.

MACHINE WORKS AND FOUNDRIES

Aluminum Drawing

Collapsible Aluminum Cup (66203). J. P. Sheehy. Ills. 1000 w. M I—Dec., 1915. Details of drawing thin metal.

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Chamfering

Chamfering Operations on the Brown and Sharpe Automatic Screw Machine (66322 A). W. Richards. Ills. 700 w. Mch W—Nov. 26, 1915. Details of work.

Drop Forging

Drop Forging (66271 N). Ills. 9 pp. Int R R Mas Blacksmiths Assn Pro—Aug., 1915. Committee report, series of short communications.

Flue Welding

Flue Welding (66267 N). 8 pp. Int R R Mas Blacksmiths Assn Pro—Aug., 1915. Committee report, series of communications.

Foundry Practice

Notes on Steel Foundry Practice (66687 A). J. Peers, in *Foundry Trade Jour.* Ills. 2500 w. Mch W—Dec. 10, 1915. Hints for making intricate castings.

Das Formen eines Girard-Turbinen-Leitapparates (66223 B). E. Emmel. Ills. 2500 w. G-Z—Nov. 15, 1915. Details of molding turbine distributor.

Recent Improvements in Foundry Operations (66306). Thomas D. West. Ills., 6500 w. Fnd—Dec., 1915. Serial, 1st part. Read at Engng. Cong. Wider use of labor-saving devices in casting plants.

Heat Treatment

The Heat Treatment of Iron and Steel in a Neutral Atmosphere (66280 N). Alfred H. White and Homer T. Hood. Ill. 16 pp. Mich Gas Assn Pro—Sept., 1915. Experimental results.

Volume Changes During the Hardening of Steel (66691 A). 2000 w. Eng—Dec. 10, 1915. Editorial review of research work at Charlottenburg Technical High School by E. H. Schulz.

Gas as a Case Hardening Agent (66281 N). Alfred H. White and Homer T. Hood. Ill. 33 pp. Mich Gas Assn Pro—Sept, 1915. Advantages based on experiment.

Carbon and High Speed Steel and Tempering of Taps and Dies (66268 N). 13 pp. Int RR Mas Blacksmiths Assn Pro—Aug., 1915. Committee report, series of communications.

Japanning

Gas vs. Electricity for Japanning and Enameling Ovens (66746). C. L. Gehnrich. Ills. 2200 w. A G L Jl—Dec. 27, 1915. Advantages of indirect gas-heated ovens.

Lacquering

The Art and Practice of Lacquering (66645). Francis A. Shepherd. 2000 w. B W—Dec., 1915. Serial, 1st part. Methods; application, effects, materials, appliances.

Machine Control

Automatic Mechanical Control of Lathes and Screw Machines (66575 N). L. D. Burlingame. Ills. 35 pp. A S M E—Dec., 1915. Most essential features.

Machine Foundations

Foundations for Jar-Ramming Molding Machines (66716 N). E. S. Carman. Ills. 1000 w. A F A—Oct., 1915. Early types and recent developments.

Machine Tools

Entwicklung und Ziele im deutschen Grosswerkzeugmaschinenbau (66254 B). Arthur Schmidt. Ills. 2700 w. Z V d I—Dec. 4, 1915. Development of design, and scope of exceedingly heavy machine tools.

Molding Machines

The History and Development of the Molding Machine with Sidelights on Latter-Day Practice (66718 N). J. J. Wilson and A. O. Backert. Ills. 71 pp. A F A—Oct., 1915. Classification and fields.

Neuerungen im Formmaschinenbau und Giessereibetrieb (66224 B). Pradel. Ills. 2000 w. G-Z—Nov. 15, 1915. Serial, 1st part. Recent German patents in molding machines, etc.

Molding Machines

Neuere Bauarten Bonvillainscher Formmaschinen (66273 B). U. Lohse. Ills. 2600 w. St u E—Nov. 25, 1915. Recent improvements in molding machines made by Bonvillain & Ronceray of Paris.

Munitions

Munitions Making for Small Manufacturers (66286 A). Ills. 4000 w. E M—Jan., 1916. Account of work possible with present equipment, costs, profits, precautions.

Patterns

Plaster-of-paris as a Patternmaking Material (66810 A). D. Gordon, in *Found. Trd. Jour.* Ills. 1500 w. Mch W—Dec. 17, 1915. Producing at reduced cost.

Altering Old Patterns (66458 A). William J. Horner. Ills. 1300 w. Mch W—Dec. 3, 1915. Examples.

Projectiles

Les machines-outils pour l'usinage des obus (66260 B). F. Hofer. Ills. 3000 w. G C—Dec. 11, 1915. Characteristics of shell-making machines; numerous examples.

La fabrication des obus (66221 B). Ch. Dantin. Ills. 5000 w. G C—Nov. 20, 1915. Processes of shell manufacture at French plants.

Cutting-Off and Facing Machines for Projectile Work (66075 A). Ills. 500 w. Eng—Nov. 19, 1915. Designed for rapid work.

High-Explosive Shell Manufacture (66099 A). Douglas T. Hamilton. Ills. 10500 w. Mch—Dec., 1915. Types and parts.

High-Explosive Shell Cartridge Cases (66103 A). Ills. 4000 w. Mch—Dec., 1915. Details of work.

Forging High-Explosive Shells (66100 A). Ills. 2000 w. Mch—Dec., 1915. New methods.

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Machining High-Explosive Shells (66101 A). Ills. 4500 w. Mch—Dec., 1915. Methods in different countries.

Detonating Fuses for High-Explosive Shells (66102 A). Ills. 3000 w. Mch—Dec., 1915. Operations described.

Single Purpose Machines in Shell Making (66094 A). C. A. Tupper. 3000 w. I A—Dec. 2, 1915. Machines needed to produce 100 shells per hour.

Pulleys

Pulley Moulding by Machine (66323 A). Joseph G. Horner. Ills. 1800 w. Mch W—Nov. 26, 1915. Method.

Scrap

Best Method of Reclaiming Scrap (66269 N). 10 pp. Int RR Mas Blacksmiths Assn Pro—Aug., 1915. Committee report, series of communications on costs.

Economy in Scrap Yard Arrangement (66543 A). Ills. 1000 w. I A—Dec. 16, 1915. Reducing handling costs in Youngstown plant.

Shop Practice

Machine Shop Equipment and Methods (66096 A). 2500 w. I A—Dec. 2, 1915. Résumé of important developments, as given in papers by E. R. Norris and by H. F. L. Orcutt at Int. Engng. Cong.

Shops

Modern Ideas in a New England Shop (66708 A). W. E. Freeland. Ills. 1200 w. I A—Dec. 23, 1915. Plant of Athol Machine Co.

Large Frog and Switch Plant at Easton Built in Practically One Year (66152). Ills. 1500 w. E R—Dec. 4, 1915. New works of Wharton Co.

See also manufacture under ELECTRICAL ENGINEERING, *Transformers*.

Stamping

Speeding Up Metal Stampings Production (66242). Charles C. Lynde. Ills. 2000 w. S & I—Dec., 1915. Machines and system for good practice.

Tooth-Rests

The Application of Tooth-Rests (66809 A). Joseph Horner. Ills. 800 w. Mch W—Dec. 17, 1915. Serial, 1st part. Forms and work.

Tunnel Linings

Machining and Molding Cast Tunnel Linings (66093 A). Louis J. Josten. Ills. 2000 w. I A—Dec. 2, 1915. Special machinery employed.

Welding

Electric Welding (66272 N). Ills. 14 pp. Int RR Mas Blacksmiths Assn Pro—Aug., 1915. Committee report, practice of different shops.

Discussion on "Answers to Some Questions on Electric Arc Welding" (Lincoln), Cleveland, Ohio, March 19, 1915 (66663 D). 2500 w. A I E E—Dec., 1915.

Electric Welding Machine (66633 A). Ills. 1000 w. Eng—Dec. 3, 1915. Power driven semi-automatic machine of British make.

Gas Welding and Cutting (66655 B). I. Welding Heavy Parts. C. K. Bryce. II. Use in Steel Foundries. J. B. Henry. III. Armor Plate Cutting. A. F. Mitchell. With Discussion. Ills. 30 pp. E S W P—Nov., 1915.

Oxy-Acetylene Welding (66447 A). M. H. F. Koch. 15 pp. S & S-W R C, Pro—Sept., 1915. Experience.

Oxyacetylene Welding at Braden (66146). Alma E K and J. R. Thill. Ills. 1500 w. E & M J—Dec. 4, 1915. Details of mine and smeltery work.

Wire Drawing

Power Requirements for Wire Drawing (66243). Kenneth B. Lewis. Ills. 1500 w. B F & S P—Dec., 1915. Formulas and application.

Wire Rods

How to Heat Wire Rods by Continuous Coil Method (66105). Ills. 3500 w. I T R—Dec. 2, 1915. Methods used at North Tonawanda, N. Y., by the Buffalo Bolt Co.

MATERIALS OF CONSTRUCTION

Allotropy

Metastability of Metals (66461). 1500 w. M & C E—Dec. 15, 1915. Work of Prof. E. Cohen.

Alloy Steel

A Development of a High-Grade Alloy Steel at Low Cost (66478 A + D). J. B. Rhodes. 1200 w. A S N E—Nov., 1915. Castings and forgings from same mix.

Belting

The Manufacture of Leather Belting (66188 A). F. H. Small. 5000 w. A S M E Jl—Dec., 1915. Tanning and subsequent treatment.

Brass

Constitution of Brasses (66690 A). O. F. Hudson and R. M. Jones. Read before the Inst. of Metals, London. Ills. 3000 w. Eng—Dec. 10, 1915. Brasses containing small percentages of tin; alloys of copper, zinc and tin.

Bronze

A Metallographic Description of Some Ancient Peruvian Bronzes from Machu Picchu (66511 B). C. H. Mathewson. Ills. 74 pp. A Jl S—Dec., 1915. Metallographic study of characteristics and conclusions drawn.

See also Copper.

Copper

Kupfer und Bronze (66215 B). W. Müller. Ills. 2500 w. Z V d I—Nov. 13, 1915. Study of effect of working and heat treatment on tensile strength of copper and bronze.

Electric Furnaces

The Electric Furnace in the Foundry (66425 D). 1700 w. A I M E Bul—Dec., 1915. Discussion of William G. Krauz's paper.

Ghost Lines

The Cause and Effect of "Ghost Lines" in Large Steel Forgings (66329 N). J. O. Arnold. Ills. 3200 w. I Mch E—Nov. 19, 1915. Research work.

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Insulating Materials

The Thermal Insulation of High Temperature Equipment (66426 D). Ills. 1500 w. A I M E Bul—Dec., 1915. Discussion of P. A. Boeck's paper.

The Heat Insulating Properties of Commercial Steam Pipe Coverings (66560 N). L. B. McMillan. Ills. 50 pp. A S M E—Dec., 1915. Extensive laboratory investigations.

Lubricants

Value and Economy of Lubricants (66044). E. A. Siebel. Read before the Natl. Assn. of Sta. Engrs. 3500 w. N E —Dec., 1915. Characteristics and criteria.

Viscosity and Rate of Flow of Hydro-Carbon Oils (66077 A). 3500 w. Eng—Nov. 19, 1915. Editorial review of discussion in Inst. of Petroleum Technologists.

Manganese Steel

Manganese-Steel Castings in the Mining Industry (66414 D). Walter S. McKee. Ills. 4000 w. A I M E Bul—Dec., 1915. Characteristics and applications.

Pig Iron

Comments on the Tendencies of Merchant Pig Iron (66715 N). Oliver J. Abell. 1600 w. A F A—Oct., 1915. Purchase and sale for manufacture of castings.

Shop Chemicals

Acids and Alkalies for Shop Use (66325 A). E. H. Fish. 3000 w. Mch W—Nov. 26, 1915. Machine shops uses and general information.

Steel

Sur l'hétérogénéité des aciers (66232 C + D). Henry Le Chatelier and Jules Lemoine. Ills. 6 pp. R Met—July, 1915. Causes of layers of perlite as revealed by Stead's reagent.

Alumina in Steel (66082). George F. Comstock. Ills. 2000 w. M & C E—Dec. 1, 1915. Difference between inclusions of alumina and silicates.

The Effect of Carbon on the Physical Properties of Heat-Treated Carbon Steel (66410 D). J. H. Nead. Ills. 1800 w. A I M E Bul—Dec., 1915. Experimental investigations.

The Chemical and Mechanical Relations of Iron, Molybdenum, and Carbon (66330 N). J. O. Arnold and A. A. Read. Ills. 5000 w. I Mch E—Nov. 19, 1915. Results of research work.

An Investigation of the Effect Produced by Varying the Sulphur Content of Basic Open Hearth Steel (66858 N). J. S. Unger. Ills. 3000 w. S A E—Jan., 1916. Investigation.

Steel Castings

Lack of Uniformity in Steel Castings (66709 A). J. H. D. Eagan. 2000 w. I A—Dec. 23, 1915. Causes and remedies.

The Initial Structure of Steel Castings (66095 A). Edwin F. Cone. Ills. 2500 w. I A—Dec. 2, 1915. Microscopic study.

Wire Rope

The Care of Wire Rope (66686 A). Bruce W. Bennett. Abstract of paper read before the Shamokin Min. Inst. 2000 w. Mch E—Dec. 10, 1915. Suggestions and cautions.

Wire Rope: A Factor in Steel Making (66735). James F. Howe. 8000 w. I T R—Dec. 23, 1915. Read before the Assn. of Ir. & St. Elec. Engrs. Usage; reasons which led to its adoption.

MEASUREMENT

Automatic Calculators

Essais sur l'automatique (66219 B). Leonardo Torres y Quevedo. Ills. 11 pp. R G S—Nov. 15, 1915. Principles of automatic machines and especially action of author's "thinking machine."

Cottrell Process

Gas Volume and Dust Concentration Determination in Connection with the Cottrell Process (66187 A). William N. Drew. Ills. 2000 w. A S M E Jl—Dec., 1915. The use of the Pitot tube for this purpose.

Dynamometer

The Solution of the Traction Equation of a Vehicle in Motion by the Power Meter (66631 A). Abstract from *Génie Civil.* Diagrams. 3000 w. Eln—Dec. 3, 1915. Details and use.

Flow

The Flow of Air Through Thin-Plate Orifices (66580 N). Ernest O. Hickstein. 20 pp. A S M E—Dec., 1915. Calibrating meter disks.

Laboratories

Der Neubau des Laboratoriums für Technische Physik der Technischen Hochschule München (66214 B). Osc. Knoblauch. Ills. 2500 w. Z V d I—Nov. 13, 1915. Layout and equipment of new laboratories for applied physics in Munich Technical High School.

Metallography

The Present-Day Knowledge of Metals and the Engineer (66648 A). Clement E. Chase. 3500 w. C C E—Dec., 1915. Importance of microscopic study of materials under stress.

Eenige resultaten van metallographisch onderzoek die van belang zijn voor den ingenieur (66222 B). E. B. Wolff. Ills. 9000 w. Ing—Nov. 20, 1915. Application of metallographic study to purposes of the engineer.

The Determination of Grain Size in Metals (66411 D). Zay Jeffries, A. H. Kline, and E. B. Zimmer. Ills. 2500 w. A I M E Bul—Dec., 1915. Comparison of methods previously used and new method, with advantages of latter.

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Festigkeitberechnung von radial belasteten Ringen (66244 B). F. Kretzschmar. Ills. 1800 w. Sch—Nov. 24, 1915. Calculations and formulas for resistance of rings loaded radially.

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Strength of Metals

Cross-Relations of Strengths of Metals in Tension, Compression, Torsion and Transverse Loading (66549 A). G. B. Upton. 4500 w. S Jl E—Dec., 1915. Results of tests.

Temperature

Ueber Temperaturmessungen bei Verdampfungsversuchen (66278 B). M. R. Schulz. Ills. 1200 w. Z g T—Nov. 20, 1915. Practice in measuring temperatures in calculating evaporation rates.

POWER AND TRANSMISSION

Building Vibrations

Graphic Analysis of Building Vibrations (66601). Elmer E. Hall. Ills. 2000 w. El W—Dec. 18, 1915. Necessity of mounting turbo-generators on independent foundations near ground.

Compressed Air

Compressed Air in Construction and Repair Work (66593). Charles C. Phelps. Ills. 1800 w. Cl A—Dec. 18, 1915. Work for which it is adapted.

STEAM ENGINEERING

Boiler Corrosion

The Internal Treatment of Boilers (66797). George Anderson. 2000 w. Pwr—Dec. 28, 1915. Scale and prevention.

A Novel Method of Handling Boilers to Prevent Corrosion and Scale (66561 N). Allen H. Babcock. 24 pp. A S M E —Dec., 1915. Successful use of "Navy Standard Boiler Compound."

Boiler Design

Design of Fire Tube Boilers and Steam Drums (66568 N). F. W. Dean. Ills. 3500 w. A S M E—Dec., 1915. Safety; construction and care.

Boiler Economy

Circulation in Horizontal Water Tube Boilers (66574 N). Paul A. Bancel. Ills. 4000 w. A S M E—Dec., 1915. Conditions at loads up to 500 per cent.

Boiler Inspection

I. The Boiler Inspector and His Job. T. T. Ryan. II. Facilities and Methods of Working. W. J. Gillespie (66185 A). 4000 w. R A G, M E—Dec., 1915. Prize article and one other.

Boiler Plants

Moxley Plant Remodeled (66639). Thomas Wilson. Ills. 1400 w. Pwr—Dec. 21, 1915. Old and new installations compared.

Chimneys

Proportioning Chimneys on a Gas Basis (66578 N). A. L. Menzin. 20 pp. A S M E—Dec., 1915. Baffling for improving boiler performance and efforts to improve efficiency of combustion.

See also Stacks under CIVIL ENGINEERING, *Construction*.

Combustion Improvers

Fuel-Combustion Improvers (66371). 2000 w. Cl A—Dec. 11, 1915. Mechanical and chemical processes.

Condensing

Surface, Jet and Evaporative Condensers (66315 N). Maurice Moore. 2000 w. C w E—Nov., 1915. Suitability of each, and method of operation.

Performance and Design of High Vacuum Surface Condensers (66573 N). George H. Gibson and Paul A. Bancel. Curves. 33 pp. A S M E—Dec., 1915.

Cooling Water

Cooling Condensing Water by Wholesale (66400). Walter B. Snow. Ills. 500 w. Pe, C—Dec. 15, 1915. Fall River plans.

Draft

What Draft Gages Tell (66800). M. K. Bryan. Ills. 1700 w. Pwr—Dec. 28, 1915. Effects of dampers.

Fuel

Fuel Economy (66108 A). W. A. Bone. 4000 w. C G—Nov. 19, 1915. National importance. (Abstract.)

Notes on the Use of Low-Grade Fuel in Europe (66359). R. H. Fernald. Ills. 30 pp. U S B M—Tech paper 123. Investigation, incomplete because of war.

Relative Costs of Coal and of Oil Fuels (66431). F. C. Fearing. 1200 w. Pwr —Dec. 14, 1915. Chart showing relative costs, with explanatory notes.

The Cheapest Fuel and Most Economical Load (66171). Robert H. Karl. 1500 w. Pwr—Dec. 7, 1915. Tests on burning screenings and nut coal.

High Pressures

Higher Steam Pressures (66567 N). Robert Cramer. 15 pp. A S M E—Dec., 1915. Possibility of improving economy of engines.

Oil Burning

See same heading under MARINE AND NAVAL ENGINEERING.

Performance

Conditions Governing Operation of Prime Movers (66378). A. A. Potter and S. L. Simmering. Effects from changes in steam pressure, superheat and vacuum.

Pulverized Fuel

Stand der Kohlenstaubfeuerungen in Deutschland (66226 B). A. B. Helbig. Ills. 2000 w. St u E—Nov. 18, 1915. Review of German development of coal-dust firing.

Smoke

Recent Progress in Boiler Installations and Some Results of Furnace Investigations (66454 A). William A. Hoffman. Ills. 4000 w. A E S—Nov., 1915. Best construction.

Smoke Abatement—A Report on Recent Investigations Made at Washington University (66453 A). Ernest L. Ohle. Ills. 2500 w. A E S—Nov., 1915. Possible economy.

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Stokers

Blower Installations and Air Ducts (66049). R. A. Langworthy. Ills. 2200 w. P E, C—Dec. 1, 1915. Arrangements for forced draft stokers.

Superheating

Superheated Steam (66046). A. E. Monia. 2500 w. N E—Dec., 1915. Characteristics and use.

High Pressure Steam for Superheating (66798). 1700 w. Pwr—Dec. 28, 1915. Proposes small independent boiler.

Surface Combustion

Some Recent Experiments in Surface Combustion (66169). L. J. Bradford and C. D. Corwin. Ills. 1000 w. Pwr—Dec. 7, 1915. Serial, 1st part. Summary of literature and history.

Turbines

Turbines vs. Engines in Units of Small Capacities (66557 N). J. S. Barstow. 4500 w. A S M E—Dec., 1915. Fields of each.

Note on the Effect of Vacuum in Steam-Turbines (66074 A). Gerald Stoney. 1500 w. Eng—Nov. 19, 1915. Investigations.

See also same heading under MARINE and NAVAL ENGINEERING, and Waste Heat under *Combustion Engines.*

Waste Heat

How to Utilize Waste Heat Boilers (66734). C. J. Bacon. Read before Am. Ir. & St. Inst. Ills. 4000 w. I T R—Dec. 23, 1915. Problems and results.

Novel Industrial Power Plant (66043). Ills. 1500 w. N E—Dec., 1915. Waste heat of malleable iron furnaces utilized by boilers in Auburn, N. Y.

TRANSPORTING AND CONVEYING

Cableways

Sull'esercizio e manutenzione delle funicolari aeree (66228 B). Emilio Noe. 3000 w. M T—Nov. 10, 1915. Brief exposition of methods of building and operating aerial tramways.

Elevators

Modern Electric Elevators and Elevator Problems (66562 N). David Lindquist. Ills. 40 pp. A S M E—Dec., 1915. Practice and development.

Grab Buckets

Neuzeitliche Selbstgreifer-Konstruktionen (66253 B). Wintermeyer. Ills. 3500 w. Z V d I—Nov. 27, 1915. Recent improvements in grab-bucket design.

Material Handling

Handling Materials in Manufacturing Plants (66289 A). Robert L. Streeter. Ills. 6000 w. E M—Jan., 1916. Third article of series; uses to which conveyors may be applied.

Ore Handling

Discussion on "Application of Electricity to the Ore Handling Industry" (Gilpin), Cleveland, Ohio, March 18, 1915 (66671 D). 2500 w. A I E E—Dec., 1915.

MISCELLANY

Panama-Pacific

Engineering at the Panama-Pacific Exposition (66191 A). 4500 w. A S M E Jl—Dec., 1915. Discussion of papers by Bayley and Dickie.

Tanning Industry

The Effect of Technical Education Upon the Leather Industry (66878). Allen Rogers. Ills. 2000 w. S A—Jan. 1, 1916. Benefits derived.

MINING AND METALLURGY

BASE METALLURGY

Ashio

Ashio's Copper-Smelting Works at Honzan, Japan (66606). Ills. 1200 w. E & M J—Dec. 18, 1915. Methods used. A new dust-settling system.

Copper Leaching

Roasting and Leaching Concentrator Slimes Tailings (66419 D). 1700 w. A I M E Bul—Dec., 1915. Discussion of Lawrence Addicks' paper.

Some Problems in Copper Leaching (66418 D). 500 w. A I M E Bul—Dec., 1915. Discussion of L. D. Ricketts' paper.

Copper Reverberatories

Gas-Fired Reverberatory Furnace at Sulitjelma, Norway (66767). C. Offerhaus. Ills. 3500 w. E & M J—Lec. 25, 1915. Account of practice in smelting Elmore concentrates.

Electrolytic Copper

The Production and Properties of Electrolytic Copper (66067 A). B. Welbourn. Abstract of address to Manchester Sec. of I. E. E. 3000 w. Eln—Nov. 19, 1915. Description of processes.

Electrolytic Copper (66078 A). 2500 w. Eng—Nov. 19, 1915. Editorial review of B. Welbourn's paper.

Lead Smelting

The Advantages of High-Lime Slags in the Smelting of Lead Ores (66421 D). 600 w. A I M E Bul—Dec., 1915. Discussion of S. E. Bretherton's paper.

Zinc Blast Furnace

Tests of the Lungwitz Zinc-Smelting Process (66239 N). W. McA. Johnson. 2800 w. M M S A Bul—Nov. 30, 1915. Unsuccessful tests of smelting under pressure. With discussion.

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COAL AND COKE

Byproduct Coke

Coke Ovens Heated From Above (66338 A). Ills. 700 w. I A—Dec. 9, 1915. German tests.

Byproducts

Presidential Address to the Institution of Mining Engineers (66491 N). T. Y. Greener. 5500 w. I M E—Nov., 1915. Principally quality of coke and output of byproducts.

Coal Cutters

The "Diamond" Coal Cutting and Conveying Machines (66326 A). T. Campbell Futers. Ills. 1000 w. C G—Nov. 26, 1915. Serial. 1st part. Types of machines.

Canada

The Production of Coal and Coke in Canada During the Calendar Year 1914 (66848 N). 39 pp. C D M—No. 348. Advance chapter of annual report.

Coal Production

Production of Coal in 1914 (66437 N). C. E. Lesher. 160 pp. U S G S, II:31—Nov. 29, 1915. Statistics.

Collieries

Underwood — A Modern Colliery (66861). C. M. Young. Ills. 5500 w. Cl A—Jan. 1, 1916. Up-to-date mine in the anthracite region.

Explosions

Explosions in Mines Committee: Seventh Report (66774 A). 10000 w. C G—Dec. 10, 1915. Effects of inhaling dusts applicable for stone-dusting in mines.

Geology

The Formation of Coal-Seams in the Light of Recent Microscopic Investigations (66490 N). James Lomax. 2 parts. 2 plates, and discussion. 32 pp. I M E—Nov., 1915. Results of microscopic research.

Studies of the Geology of the Kent Coal Field (66775 A). E. A. Newell Arber. Also discussion. 6500 w. C G—Dec. 10, 1915. Serial. 1st part. The coal measure records of four borings.

Inspection

Observations and Experiences in Mine-Inspection Work (66372). J. J. Rutledge. 3000 w. Cl A—Dec. 11, 1915. Coal mining on Indian lands in Oklahoma.

Kentucky

Southern Coking Coal of the Elkhorn District May Make Chicago Iron and Steel Center (66341). 3500 w. M Rd—Dec. 9, 1915. Importance of eastern Kentucky coal coking fields.

Mine Fires

Sealing Off Mine Fires (66764). Joseph Cain. Ills. 3000 w. Cl A—Dec. 25, 1915. Care in construction and removal of seals.

Mining Plants

The Design of Bituminous Mining Plants (66654 B). William Archie Weldin. Also discussion. Ills. 75 pp. E S W P—Nov., 1915. Determining character and estimating cost.

Oxfordshire

The Concealed Oxfordshire Coal Field (66776 A). Read before S. Staffs. and Warwickshire Inst. of Min. Engrs. 2500 w. C G—Dec. 10, 1915. Striking features, productiveness, etc.

Utah

Features of Coal Mining in Utah, Principally in Carbon County (66231 A). A. C. Watts. Ills. 4500 w. C S M M—Dec., 1915. Paper before Rock. Mt. Coal Min. Inst.

GEOLOGY

Butte

The Occurrence of Covellite at Butte, Mont. (66420 D). 3500 w. A I M E Bul—Dec., 1915. Discussion of A. Perry Thompson's paper.

Fire-Brick

Metal Oxide and Sulphide Impregnation of Fire-Brick (66296 B). N. B. Davis. Ills. 2500 w. E G—Nov.-Dec., 1915. Microscopic examination of specimens. Possible relation to certain ore deposits.

Joplin

Origin of the Zinc and Lead Deposits of the Joplin Region, Missouri, Kansas and Oklahoma (66795 N). C. E. Siebenthal. Maps & Ills. 264 pp. U S G S—Bul 606. Decisions based on extensive study.

Kyshtim

The Pyritic Copper Deposits of Kyshtim, Russia (66293 B). A. W. Stickney. 11700 w. E G—Nov.-Dec., 1915. Detailed description, and features of mineralization.

Texas

Copper Deposits in the "Red Beds" of Texas (66294 B). Louis M. Richard. 5500 w. E G—Nov.-Dec., 1915. Location, geology, occurrence, etc.

Witwatersrand

The Far East Rand (66275 A). E. T. Mellor. Ill. 8 pp. M Mg—Dec., 1915. General geological description and economic importance.

IRON AND STEEL

Canada

The Production of Iron and Steel in Canada During the Calendar Year 1914 (66553 N). John McLeish. 35 pp. C D M—No. 349. Statistics.

Cuyuna

Matters of Interest to Operators Regarding the Cuyuna District (66658 N). Carl Zapffe. Map. 3000 w. L S M I—Vol. XV. General description.

Concentration of Cuyuna Ores (66659 N). Edmund Newton. Ills. 3500 w. L S M I—Vol. XX. Possible methods of beneficiation.

Electro-Metallurgy

Stoff- und Wärmebilanz des Elektro-Roheisenofens (66208 B). Bernhard Neumann. 4000 w. St u E—Nov. 1 1915. Economy of the electric pig-iron furnace in heat and material.

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Ingots
See Rails.

Pacific Coast
The Pacific Coast Iron Situation (66423 D). 2500 w. A I M E Bul—Dec., 1915. Discussion of Charles Colcock Jones' paper.

Production
The Production of Iron Ore, Pig Iron, and Steel in 1914 (66506 N). Ernest F. Burchard. 60 pp. U S G S, I:16—Dec. 9, 1915. Statistics and general review.

Rails
An Investigation of Ladle Test Ingots (66098 A). Llls. 1500 w. I A—Dec. 2, 1915. Advantages of adding aluminum. Report by Robert W. Hunt, for Am. Ry. Engng. Assn.

Commercial Production of Sound Ingots (66710 A). W. D. Bradford. Ills. 1500 w. I A—Dec. 23, 1915. Freedom from pipes by use of special mold.

Steel Plants
Minnesota Steel Company Completes Plant (66826 A). Ills. & Plate. 4000 w. I A—Dec. 30, 1915. Construction, layout, and operation.

Washed Metal
Washed Metal (66413 D). Henry D. Hibbard. Ills. 3500 w. A I M E Bul—Dec., 1915. Plant of the Brier Hill Steel Co.; and the process. Also short paper by Edward L. Ford on the removal of metalloids.

MINES AND DISTRICTS

Arizona
Gold, Silver, Copper, Lead, and Zinc in Arizona in 1914 (66552 N). V. C. Heikes. 50 pp. U S G S, I:15—Dec. 14, 1915. Statistics.

Canada
The Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and Other Metals in Canada During the Calendar Year 1914 (66847 N). 75 pp. C D M—No. 350. Advance chapter, of annual report of Canadian Department of Mines.

China
Mining in Hunan, China (66777 A). A. S. Wheeler, in *Far Eastern Review*. 2500 w. M Jl—Dec. 11, 1915. Kinds of ores worked.

Dutch Guiana
Gold Deposits of Dutch Guiana (66163). J. B. Percival. 2000 w. C M Jl—Dec. 1, 1915. Opportunities; general information.

Idaho
Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1914 (66642 N). C. N. Gerry. 60 pp. U S G S, I:18—Dec. 17, 1915. Statistics.

Madagascar
L'Industrie minerale a Madagascar (66220 B). G. Grandidier. 7 pp. R G S—Nov. 15, 1915. Serial, 1st part. Iron, gold and other minerals in the island of Madagascar.

Montana
Gold, Silver, Copper, Lead, and Zinc in Montana in 1914 (66793 N). V. C. Hicks. 40 pp. U S G S, I:21—Dec. 24, 1915. Statistics.

Nevada
Gold, Silver, Copper, Lead, and Zinc in Nevada in 1914 (66793 N). V. C. Heikes. 60 pp. U. S. G S, I:19—Dec. 21, 1915. Statistics.

Quebec
Report on the Copper Deposits of the Eastern Townships of the Province of Quebec (66849 N). J. Austin Bancroft. Ills. & Maps. 280 pp. Que. Dept Colon, Min, & Fish—1915. Field work to determine how many could be relied upon to contribute regularly to a copper smelter.

Utah
Gold, Silver, Copper, Lead, and Zinc in Utah in 1914 (66794 N). V. C. Heikes. 40 pp. U S G S, I:20—Dec. 23, 1915. Statistics.

Washington
See Idaho.

MINE OPERATION

Accidents
Electrical Accidents in Mines (66629 A). 1200 w. El R—Dec. 3, 1915. Serial, 1st part. Accidents reported to H. M. Inspectors of Mines.

Change Houses
Miners' Wash and Change Houses (66110 N). Joseph H. White. Ills. 20 pp. U S B M—Tech paper 116. Details of arrangements.

Compressed Air
Compressed-Air Equalizing System at Copper Queen (66771). Fred M. Heidelberg. Ills. 1500 w. E & M J—Dec. 25, 1915. Water-pressure storage.

Explosives
Explosives as an Aid to Engineering (66193 A). Charles E. Munroe. 3000 w. A S M E Jl—Dec., 1915. Reviews history of their use.

Die Erzeugung und Verwendung flüssiger Luft zu Sprengzwecke (66207 B). H. Diederichs. Ills. 3500 w. St u E—Nov. 11, 1915. Methods of production of liquid air and its use as an explosive, developments under war conditions.

Grouting
Grouting in a Shaft (66336). J. R. Reigart (Abstract of paper before L. Superior Min. Inst.). Ills. 2000 w. M & S P—Dec. 4, 1915. Conditions, method, results.

Haulage
Continuous Face Haulage (66765). J. F. K. Brown. 2000 w. Cl A—Dec. 25, 1915. A rope haulage system handling about 600 tons per day.

Hoisting
Mine-Hoist Calculations (66126). F. L. Stone. Ills. 2500 w. Cl A—Dec. 4, 1915. Serial, 1st part. Method for solution.

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Hoisting Rope
See Wire Rope under MECHANICAL ENGINEERING, *Materials of Construction.*

Law
Extra-Lateral Right (66703). L. F. S. Holland. Ills. 1500 w. M & S P—Dec. 18, 1915. Digest of decisions.

Locomotives
Combination Gathering Motor (66129). F. J. Foley. Ills. 1600 w. Cl A—Dec. 4, 1915. Types discarded and machine in successful operation.

Manganese Steel
See same heading under MECHANICAL ENGINEERING, *Materials of Construction.*

Power Plants
Canonsburg Gas Coal Co.'s Plant (66127). C. M. Means. Ills. 700 w. Cl A—Dec. 4, 1915. Alternating and direct current.

Prospecting
Prospecting on the Chiksan Concession (66496). Charles W. DeWitt. Ills. 1200 w. M & S P—Dec. 11, 1915. Methods used in Korea.

Shafts
Lining Shafts with Concrete Z Blocks (66489 N). Marcel Gilleaux. Plates & Ills. 3000 w. I M E—Nov., 1915. Describes process.

Shoveling Machines
Progress in Underground Ore Loading 66660 N). M. E. Richards. Ills. 2200 w. L S M I—Vol. XX. Mechanical shovels and machines tried.

Signaling
A New Battery Signalling Bell (66488 N). W. M. Thornton. Also discussion. 13 pp. I M E—Nov., 1915. Principals and details.

Storage-Battery Locomotives
Novel Combination Locomotive (66128). E. C. De Wolfe. Ills. 2000 w. Cl A—Dec. 4, 1915. Details.

Stripping
Hydraulic Stripping at Rowe and Hillcrest Mines on the Cuyuna Range, Minnesota (66656 N). Edward P. M'Carty. Ills. 2500 w. L S M I—Vol. XX. General features.

Drag-Line Stripping and Mining, Balkan Mine, Alpha, Mich, Menominee Range, Mastodon District (66657 N). Charles E. Lawrence. Ills. 1200 w. L S M I—Vol. XX. Machines and methods.

Telephones
Mine Telephone Equipment (66594). Walter C. Freeman. Ills. 2500 w. Cl A—Dec. 18, 1915. Discussion of various systems.

Ventilation
Notes on Mine Ventilation (66512). John Shanks. Ills. 2500 w. C M I—Dec., 1915. Principles.

MINOR MINERALS

Bauxite
Bauxite: A Source of Aluminum (66814 A). 2500 w. Eng—Dec. 17, 1915. Treatment—furnace; forms; sources.

Carnotite
Extraction and Recovery of Radium, Uranium and Vanadium from Carnotite (66733 N). Charles L. Parsons, R. B. Moore, S. C. Lind and O. C. Schaefer. Ills. 112 pp. U S B M—Bul. 104.

Fluorspar
The Fluorspar Mine in Colorado (66704). Horace F. Lunt. Map. 1000 w. M & S P—Dec. 18, 1915. Descriptive.

Potash
Possible Sources of Potash in America (66517 B). Frank K. Cameron. 4000 w. F I—Dec., 1915. Large potential supply.

Recent Alunite Developments Near Marysvale and Beaver, Utah (66360). G. F. Loughlin. Maps. 34 pp. U S G S, Bul 620-K—Dec. 3, 1915. Report of field work during 1914.

Potash in Certain Copper Ores and Tailings 66396). B. S. Butler. 1200 w. M & E W—Dec. 11, 1915. Analyses of ores from different districts.

Tungsten
Wolframite Mining in the Tavoy District, Lower Bureau (66699 N). 6000 w. I M M, Bul 135—Dec. 9, 1915. History and detailed description of methods, etc.

Tungsten
The Black Hills of South Dakota a Good Producer of Tungsten (65904). Jesse Simmons. 500 w. M & E W—Nov. 20, 1915. Known areas of tungsten ores.

OIL AND GAS

California
Notes on Santa Maria Oilfields (66406 A). Paul W. Prutzman. Read before Am. Petroleum Soc. 1500 w. W E—Dec., 1915. California field.

Dakota Sand
Oil, Gas, and Water Contents of Dakota Sand in Canada and United States (66415 D). 1200 w. A I M E Bul—Dec., 1915. Discussion of L. G. Huntley's paper.

Drilling
The Development of the Steel Drilling-Rig (66402 A). R. B. Woodworth. Read before Am. Petroleum Soc. 4500 w. W E—Dec., 1915. History.

Fire Hazard
Factors Affecting Fire Hazard of Oil Producing and Refining Properties (66403A). A. W. Gunnison. Abstract of paper before Am. Petroleum Soc. 1500 w. W E—Dec., 1915. Precautions.

Gasoline
See same heading under MECHANICAL ENGINEERING, *Combustion Motors.*

Louisiana
Enormous Oil Production Increase in Fields of North Louisiana (66104). Grant Richardson. 1500 w. M Rd—Dec. 2, 1915. Production; rapid development.

Mexico
The Effect of Igneous Intrusions on the Accumulation of Oil in the Tampico-Tuxpam Region, Mexico (66295 B). E. De Golyer. 3500 w. E G—Nov.-Dec., 1915. Conclusions from study.

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Natural Gas

Natural Gas—Its Occurrence and properties (66381). Dorsey Hager. Ills. 3000 w. E & M J—Dec. 11, 1915. General résumé.

The Productions of Natural Gas in 1914. (66643 N). John D. Northrop. 70 pp. U S G S, II:32—Dec. 15, 1915. Statistics.

Oil Expansion

The Coefficient of Expasion of California Crude Oils and Distillates (66401 A). A. S. Crossfield. Read before Am. Petroleum Soc. 3000 w. W E—Dec., 1915. Summary of results of investigation by Bureau of Mines.

Pumping

Pumping California Crude Oil (66140). C. P. Bowie. Ills. 3600 w. E N—Dec. 2, 1915. Practice.

Refining

European Refining Methods (66404 A). Leopold Seelenfried. Address before Am. Petroleum Soc. 1500 w. W E—Dec., 1915. Austro-Hungary and Rumania.

The Cracking and Distillation of Petroleum Under Pressure (66518 B). Benjamin T. Brooks. 5000 w. F I—Dec., 1915. Many processes patented; increasing the supply of motor fuel.

Washington

The Possible Occurrence of Oil and Gas Fields in Washington (66416 D). 1200 w. A I M E Bul—Dec., 1915. Discussion of Charles E. Weaver's paper.

Water Protection

Protecting California Oil Fields from Damage by Infiltrating Water (66408 D). R. P. McLaughlin. Also discussion. Ills. 6500 w. A I M E Bul—Dec., 1915. Outlines the problem.

ORE DRESSING

Braden

The Concentrator of the Braden Copper Company (65470 N). Ills. 2000 w. T T—Oct., 1915. General description.

Clay

Clay: Its Relation to Ore Dressing and Cyaniding Operations (66698 N). A. W. Allen. 6000 w. I M M, Bul 135—Dec. 9, 1915. Colloidal compared with non-colloidal.

Development

The Evolution of Ore-Dressing Methods (66780). Robert H. Richards. Read at Int. Engng. Cong., San Francisco. 3000 w. C M Jl—Dec. 15, 1915. Reviews development and improvements in the art.

Electrostatic Separation

Electro-Static Separation of Pyritic Zinc Ores (66705). J. H. Lewis. Ills. 1700 w. M & S P—Dec. 18, 1915. Principal features of five distinct types of magnetic separators.

Flotation

Flotation v. Wet Concentration (66427 N). 1800 w. M & E R—Nov. 5, 1915. General discussion.

The Electrical Theory of Flotation (66090). Thomas M. Bains, Jr. 2500 w. M & S P—Nov. 27, 1915. Interpretation, involving electrostatics.

Notes on Flotation (66409 D). J. M. Callow. Ills. 5000 w. A I M E Bul—Dec., 1915. History. Callow process; theory.

Effects of Soluble Components of Ore on Flotation (66706). 1500 w. M & S P—Dec. 18, 1915. Fouling agents; methods for overcoming.

Flotation—A Paradox (66816 A). Dudley H. Norris. 3500 w. M & S P—Dec. 25, 1915. Patent questions.

The Status of Flotation Litigation (66702). 1200 w. M & S P—Dec. 18, 1915. Editorial explanation.

Flotation—Its Progress and Its Effect Upon Mill Design (66866). C. A. Tupper. Ills. 5000 w. M & E W—Jan. 1, 1916. Present situation; tendencies.

Disposal of Flotation Residue (66495). W. Shellshear. Ills. 2500 w. M & S P—Dec. 11, 1915. Abstract from *Min. & Eng. Rev.* Methods in Australia.

Flotation at the Consolidated Arizona Smelting Co., Humboldt, Arizona (66084). 2500 w. M & C E—Dec. 1, 1915. Methods and costs.

Flotation at Globe-Miami, Ariz. (66607). 1500 w. E & M J—Dec. 18, 1915. Inspiration and other plants.

Flotation of Silver-Lead Mineral at a New South Wales Mine (66380). H. Hardy Smith. Ills. 3000 w. E & M J—Dec. 11, 1915. Silver Peak mill of Yerranderia district; operating details.

Flotation at Gold Hunter Mill (66770). Ills. 900 w. E & M J—Dec. 25, 1915. Practice in Coeur d'Alenes.

Flotation Plant of the Utah Leasing Company (66497). Herbert Salinger. 700 w. M & S P—Dec. 11, 1915. Plant at Newhouse, Utah.

Magnetic Separation

Magnetic Separation in Sardinia (66144). Charles W. Wright. Ills. 1200 w. E & M J—Dec. 4, 1915. Ulrich machines used with successful results.

PLACER MINING

British Columbia

Acquiring Placer-Mining Claims in British Columbia (65561). J. A. Macdonald. Ills. 1500 w. E & M J—Nov. 6, 1915. Details of requirements.

Dredging in 1915

Dredging Operations at the Beginning of 1916 (66868). Ills. 6500 w. M & E W—Jan. 1, 1916. Editorial review.

Prospecting

Prospecting Gold Gravel with Keystone Drills (66779). From report of J. D. Galloway on conditions in Cariboo division, B. C. 2000 w. C M Jl—Dec. 15, 1915. Information on operations.

Sluicing

Sluicing Methods at Fairbanks (66605). Hubert I. Ellis. Ills. 2500 w. E & M J—Dec. 18, 1915. Details.

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Yukon

Development of Dredging in Yukon Territory (66769). O. B. Perry. Read before the Can. Min. Inst. Ills. 3500 w. E & M J—Dec. 25, 1915. Problems and their solution.

PRECIOUS METALLURGY

Amalgamation

Clean-Up Room Practice at the Summer Deep (66297 N). W. H. Jane and E. Davey. 3300 w. C M M S S A—Oct., 1915. Methods.

Cottrell Process

Treatment of Silver Furnace Fume by the Cottrell Process (66394). Charles H. Aldrich. 2500 w. M & E W—Dec. 11, 1915. Recovery of metal values from gases.

Cyaniding

Influence of Heat in Cyaniding Gold Ores (66697 N). E. A. Wraight. 2500 w. I M M, Bul. 135—Dec. 9, 1915. Experimental investigations and conclusions.

Precipitation With Zinc - Thread (66494). Jay A. Carpenter. 3000 w. M & S P—Dec. 11, 1915. Advantages.

The Cyanide Plant of the Baker Mines Co., Cornucopia, Oregon (66460). Robert M. Keeney. Ills. 4500 w. M & C E—Dec. 15, 1915. Description.

Nevada Packard Reduction Plant at Rochester, Nev. (66027). K. Freitag. 1200 w. M & E W—Nov. 27, 1915. Plant and method.

Cyanidation in Western Australia (66089). V. F. Stanley Low. Ills. 3000 w. M & S P—Nov. 27, 1915. Details of plant in Yilgarn district.

The Metallurgy of the Sons of Gwalia Mine Ore (66313 N). Thomas B. Stevens. 4500 w. C M W A Jl—Sept., 1915. Amalgamation and cyanidation.

Metallurgical Practice in the Witwatersrand District, South Africa (66417 D). 8000 w. A I M E Bul—Dec., 1915. Discussion of F. L. Bosqui's paper.

MISCELLANY

Conservation

Conservation of Mineral Resources (66145). Excerpts from address by H. M. Chance. 1700 w. E & M J—Dec. 4, 1915. Conservation of labor important.

Copper

Copper in 1914 (66432 N). B. S. Butler. 56 pp. U S G S, 1:17—Dec. 8, 1915.

Production

Post - Bellum Mineral Production (66292 A). Arthur Selwyn-Brown. 2500 w. E M—Jan, 1916. Predicts continuance of present high production.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Block Signaling

Mileage of American Railroads Block Signaled (66846). 3000 w. R A G—Dec. 31, 1915. Space interval in use on nearly 100,000 miles.

Cab-Signaling

Cab-Signaling and the Pollokshaws Collision (66319 A). Diagram. 1500 w. R G—Nov. 26, 1915. Weaknesses of line semaphore system, details of "Raven" system.

Derailments

Car Derailments, Causes and a Remedy (66181 A). H. M. Perry. Ills. 1200 w. R A G, M E—Dec., 1915.

Signaling

British and American Railroad Signaling (66301). T. S. Lascelles. Ills. 3500 w. Sg E—Dec., 1915. Differences in practice.

Signal Protection

Protection of Railway Signal Circuits Against Lightning Disturbances (66056 A). E. K. Shelton. 1200 w. G E R—Dec., 1915.

MOTIVE POWER AND EQUIPMENT

Air Brakes

Effect of Moisture in the Air Brake System (66183 A). 1200 w. R A G, M E—Dec., 1915. Troubles caused.

Handling Defective E. T. Equipment (66177 A). 2500 w. R & L E—Dec., 1915. Suggestions for emergencies.

New York Air Brake Company's P. S. Electro-Pneumatic Brake Designed to Meet High-Speed Traffic Requirements (66176 A). Ills. 1000 w. R & L E—Dec., 1915. Principal features.

Car Lighting

Electric Lighting of Passenger Cars (66182 A). E. S. M. Macnab. 2500 w. Abstract of paper before Can. Ry. Club. R A G, M E—Dec., 1915. Systems and maintenance.

Dynamometer Cars

Swiss Railways Dynanometer Car (66180 A). H. A. Gaudy. Ills. 3300 w. R A G, M E—Dec., 1915. Equipment.

Electrification

"Electrical Railways (66852 N). Henry Metcalf Hobart. Maps & Curves. 57 pp. I C E—Dec. 14, 1915. James Forrest lecture. Development.

Developments of Future in Electrification (66873). 4000 w. El R Jl—Jan. 1, 1916. Discussed by prominent engineers.

Die massgebenden Gesichtspunkte bei der Systemwahl der elektr. Zugförderung (66274 B). W. Kummer. Ills. 2200 w. S B—Dec., 11, 1915. Decisive factors determining choice of electric traction system.

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Estimated Costs of Chicago Terminal Electrification (66398). Maps and charts. 6500 w. El R Jl—Dec. 11, 1915. Abstract of part of negative report.

Electrification of Four Mountain Divisions of the C. M. & St. Paul Railway (66650 A). A. C. Irwin. Ills. 1500 w. C C E—Dec., 1915. Interesting features.

Electrification of Charles City Western Ry. (66621). Ills. 4000 w. El T—Dec., 1915. Changed from gasoline motor car operation.

Results of Six Years Heavy Haulage (66308). Walter D. Hall. Ills. 3300 w. El Jl—Dec., 1915. Single-phase electric traction, Grand Trunk Ry. system.

London and South Western Railway Electrification (66106 A). Ills. 12000 w. T & R W—Nov. 18, 1915. Conversion of suburban lines.

The Electrification of the Riksgräusen Railway and its Rolling-Stock (66689 A). Ills. 2000 w. Eng—Dec. 10, 1915. Serial, 1st part. General description.

Electric Locomotives

The First 3000-Volt Locomotive for the Chicago, Milwaukee & St. Paul Railway Company (66062 A). E. S. Johnson. Ills. 1800 w. G E R—Dec., 1915. Interesting data.

Gondola Cars

Extensive Equipment of Steel Gondola Cars for the Imperial Russian Government Railways (66178 A). Ills. 1500 w. R & L E—Dec., 1915. Built at McKee's Rocks.

Handling Equipment

The Promotion of the Proper Handling of Equipment (66464 A). E. E. Betts. Also discussion. 1400 w. W R C—Sept. 21, 1915. Car service rules and recommendations for revision.

Instruction Cars

A South American Railway Instruction Car (66556 A). Ills. 1000 w. Enr—Dec. 3, 1915. For Central Argentine Ry. Co.

Locomotive Construction

Bemerkungen über den Zusammenbau der Lokomotiven (66216 B). Fr. Landsberg. Ills. 6000 w. G A G B—Nov. 15, 1915. Notes on methods of assembling locomotives.

Locomotive Design

Operation of Parallel and Radial Axles of a Locomotive by a Single Set of Cylinders (66563 N). Anatole Mallet. Ills. 5000 w. A S M E—Dec., 1915. Examination of many arrangements proposed.

Locomotive Equipment

Baldwin Locomotives for C. B. & Q. (66801 A). Ills. 2000 w. R M M—Dec., 1915.

Converted Atlantic Type Locomotive—Great Northern Railway (66071A). Ills. 300 w. R G—Nov. 19, 1915.

Heavy Pacific Type Locomotive for the Lackawanna (66759). Ills. 800 w. R A G—Dec. 24, 1915.

2-6-0 Mogul Type of Locomotive for General Switching Service on the Newburgh and South Shore Railway (66175 A). Ills. 700 w. R & L E—Dec., 1915.

Powerful Pacific Type Locomotive for the R., F. & P. (66583). Ills. 800 w. R A G—Dec. 17, 1915. Exceeds all previous Pacific type engines in tractive effort.

Locomotive Inspection

Locomotive Inspection (66448 A). Frank McManamy. Also discussion. 9500 w. S & S-W R C, Pro—Nov., 1915. Requirements of boiler inspection rules.

Locomotive Testing

Laboratory Tests of a Consolidation Locomotive (66641 N). E. C. Schmidt, J. M. Snodgrass, and R. B. Keller. Ills. 125 pp. U I, Bul 82—Sept. 13, 1915. Tests to determine general performance and after repairs.

Locomotive Testing Plant, Iowa State College (66165). Ills. 700 w. R R—Dec. 4, 1915. Plant with latest apparatus.

Motor Cars

The Thomas Transmission Loco-coach (66773 A). Ills. 2500 w. T & R W—Dec. 9, 1915. Details of design.

Passenger Cars

New Carriages for Royal Siamese State Railways: Southern Line, Metre Gauge (66320 A). Ills. 1000 w. R G—Nov. 26, 1915. Dimensions and general design.

Steel Cars for Michigan Railway (66397). Ills. 3000 w. El R Jl—Dec. 11, 1915.

Review of 1915

Cars and Locomotives Ordered and Built in 1915 (66844). Also editorial. 6000 w. R A G—Dec. 31, 1915. Extension of all-steel equipment, foreign orders during last quarter.

Shop Practice

Reclaiming Material at Local Shops (66184 A). E. A. Murray. Ills. 1800 w. R A G, M E—Dec., 1915. Salvaging of scrap.

Superior Methods of Reclamation, Buffalo, Rochester, and Pittsburgh Ry. (66392). Ills. 1200 w. R R—Dec. 11, 1915.

Superheaters

Superheater for Locomotive Boilers Having Small Flue Tubes (66321 A). Ills. 1200 w. R G—Nov. 26, 1915. Designed by J. G. Robinson. Details of the "Side-Header" superheater.

Trucks

Four-Wheel Trucks for Passenger Cars (66571 N). Roy V. Wright. Ills. 2500 w. A S M E—Dec., 1915. Discussion of characteristics.

Valve Gears

Equalizing Cut-offs in Walschaertz Valve Gears (66803 A). E. O. Waters. Diagrams. 2500 w. R M M—Dec., 1915. Method.

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PERMANENT WAY AND BUILDINGS

Concrete Track Footings

Het proefspoor op voeten van gewapand beton in de lijn Amsterdam-Utrecht van de Staatsspoorwegen (66233 B). K. den Tex. Ills. 1000 w. Ing—Nov. 27, 1915. Experimental track in Holland laid with reinforced concrete footings under ties.

Construction Methods

Construction Methods and Equipment of Railways (66781). William Griffith Sloan. 3500 w. Cn E—Dec. 23, 1915. From a paper before Int. Engng. Cong. Classes of work; new methods.

How Australia Builds Its Railroads (66151). Extracts from Maurice E. Kernot's paper before the Engng. Cong. 3000 w. E R—Dec. 4, 1915. Why direct labor has supplanted the contractor.

Efficiency

Efficiency in the Bridge and Building Department (66592). George W. Rear. 3000 w. R A G—Dec. 17, 1915. Discusses important principles.

Electric Lighting

Bruston Electric System of Lighting (66179 A). Ills. 700 w. R & L E—Dec., 1915. For smaller stations and roundhouses.

Encroachments

Protecting the Right of Way From Encroachments (66584). W. F. Rench. 2500 w. R A G—Dec. 17, 1915. Legal protection; means of retaining title.

Grade Separation

A Study of Grade Crossing Elimination in Cities (66652 B). C. N. Bainbridge. Also discussion. Ills. 43 pp. W S E—Oct., 1915. General features.

Belt Line Is Proposed as Solution of Dallas Grade-Crossing Problem (66384). Ills. 3500 w. E R—Dec. 11, 1915. John F. Wallace's plan for removing grade-crossings.

The Elimination of Grade Crossings in Dallas, Tex. (66363). Map. 2000 w. R A G—Dec. 10, 1915. Belt line better solution than track elevation.

A Large Track Depression Project at Minneapolis (66157). C. N. Bainbridge. Ills. 3500 w. R A G—Dec. 31, 1915. Concrete steel viaducts to eliminate 37 grade crossings.

Location

The Locating of a New Line (66783). David Wilson. From paper before Int. Engng. Cong. 2800 w. Cn E—Dec. 23, 1915. Problems in S. Africa.

Sidings

Location of Passing Sidings on Single Track (66763). F. L. Dodgson. 1800 w. R A G—Dec. 24, 1915. To obtain maximum capacity of road.

Stations

New Los Angeles Station Provides Unusual Conveniences for Passengers (66788). Ills. 1400 w. E R—Dec. 25, 1915. Ramps instead of stairways; ticket-office innovations, etc.

The Use of Brick for Station Platforms (66863). Edwin G. Zorn. Ills. 1200 w. R R—Jan. 1, 1916. Advantages and cost.

Track Materials

Tables for the Distribution of Track Materials (66588). Kenneth L. Van Auken. 1000 w. R A G—Dec. 17, 1915. Information for unloading ties, bolts, spikes, and other supplies from moving train.

Tracks

Construction of the Roadbed and of the Track (66466). E. A. Hadley. Also discussion. 5000 w. S L R C—Nov. 12, 1915. Materials and methods used.

Track Scales

A Plate Fulcrum Track Scale (66590). Ills. 1000 w. R A G—Dec. 17, 1915. Installed at East Tyrone, Pa., by Penn. R. R.

Yards

Freight Yard at Birmingham, Ala. (66356). Ills. 2000 w. E N—Dec. 9, 1915. New gravity switching yard.

ROADS AND PROJECTS

Africa

Railway Development in Africa (66635 A). 3000 w. Eng—Dec. 3, 1915. Editorial on problems.

Brazil

Railways of Brazil (66390 A). F. A. Molltor. Ills. 2000 w. R E & M W—Dec., 1915. Southern Brazil.

Eskdale

The Eskdale Railway: a Narrow-Gauge Equipment (66688 A). Maps & Ills. Plates. 4500 w. Eng—Dec. 10, 1915. Serial, 1st part. Details of a 15-in. road and rolling stock.

India

Indian Railways (66081 A). 3500 w. Enr—Nov. 19, 1915. Serial, 1st part. Review of administration report for year ended March 31, 1915.

Italy

Passaggio ferroviario dello Spluga (66259 N). Emilio Bertta. Ills. 9 pp. C I A At—Sept.-Oct., 1915. Arguments for Spluga Pass route through Alps.

Mersey Ry.

Notes on the Mersey Railway (66637 A). Joshua Shaw. Map. 2500 w. R G—Dec. 3, 1915. Serial, 1st part. Read before Liverpool Engng. Soc. History and detailed description.

Mexico

A Review of the Report of Captain Andrew Talcott, Chief Engineer Mexico and Pacific Railroad, Eastern Division from Vera Cruz to Mexico Explorations, Surveys, Estimates, 1858 (66720 D). Emile Low. Maps. 20500 w. A S C E—Dec., 1915. Details of history from notes.

New York Central

Four-Tracking of the Hudson Division of the New York Central R. R. (66391). Ills. 2000 w. R R—Dec. 11, 1915. Relocation, grading, new structures.

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United States
New Railway Construction Statistics for 1915 (66845). Also editorial. 4500 w. R A G—Dec. 31, 1915. Less track built in U. S. than for any year since 1864.

TRAFFIC

Rates
Change of Railroad Rates in West Virginia (66373). J. W. Dawson. 4000 w. Also editorial. Cl A—Dec. 11, 1915. Abstract of paper read before the W. Va. Board of Trade, Fairmont, W. Va.

Tonnage Rating
Road Trials to Determine Tonnage Rating (66369). E. S. Barnum. 700 w. R A G—Dec. 10, 1915. Proper method.

War Operation
The Railroad Soldier at the Front (65318). Walter S. Hiatt. 900 w. R A G—Oct, 29, 1915. Transportation problems, construction work, and other war tasks.

MISCELLANY

Military
Importance of Railroads in a Plan of Preparedness (66365). George Dallas Dixon. 3000 w. R A G—Dec. 10, 1915.
The Railroads and National Defense (66465 A). George D. Snyder. Also discussion. 20000 w. N Y R C—Nov. 19, 1915. Necessary preparation for handling troops and supplies.

Radial Railways
Radial Railways (66782). R. O. Wynne-Roberts. 1200 w. Cn E—Dec. 23, 1915. Benefits.

Railway Situation
The Railway Situation from Different Viewpoints (66842). 13800 w. R A G—Dec. 31, 1915. Short articles by Julius Kruttschnitt; Frank Trumbull; Judson C. Clements; Robert R. Prentis; C. H. Markham; W. B. Scott; W. J. Eck; Frank Nay; George Gibbs and W. A. Rogers.

STREET AND ELECTRIC RAILWAYS

Contact Systems
Discussion on "Unprotected Top-Contact Rail for 600-Volt Traction System" (Jones), "Third Rail and Trolley System of the West Jersey and Seashore Railroad" (Duer), "Contact System of the Southern Pacific Company, Portland Division" (Lebenbaum), "Construction and Maintenance Costs of Overhead Contact Systems" (Amberg and Zogbaum), "Contact System of the Butte, Anaconda and Pacific Railway" (Cox), and "Contact Conductors and Collectors for Electric Railways" (Hixson), Deer Park, Md., July 1, 1915 (66672 D). Ills. 4000 w. A I E E—Dec., 1915.
Note sulla costruzione di linee di contatto per trazione elettrica (66250 B). G. Bianchi Quattrosoldi. Ills. 2000 w. Ind—Dec. 5, 1915. Serial, 1st part. General survey of methods and details in construction of contact lines for electric traction.

High Tension
Mit hochgespanntem Gleichstrom betriebene Bahnen (66248 B). J. Winkler. Ills. 1500 w. P R—Nov. 24, 1915. Serial, 1st part. Locomotives and motor cars for use with high-tension direct current.

Maintenance
Reducing Maintenance Costs on a Single-Phase Railway (66158). Ills. 3500 w. El R Jl—Dec. 4, 1915. Details of economies developed.

Motors
Luftgekühlte Strassenbahnmotoren. (66257 B). Leonhard Adler. Ills. 3000 w. E u M—Dec. 5, 1915. A E G design for air-cooled tramway motors.

One-Man Cars
One-Man Cars Becoming Popular (66872). Ills. 4000 w. El R Jl—Jan. 1, 1916. Favorable reports.

Rail Bonds
Rail Bond Testing—I—Methods Used in Testing (66160). H. H. Febrey. Ills. 1500 w. El R Jl—Dec. 4, 1915. Serial, 1st part. Details of testers.

Railless
Trolley Omnibuses versus Motor Omnibuses (66772 A). Harry Webber. Ills. 3000 w. T & R W—Dec. 9, 1915. Compares results obtained.

Rails
Curved Heads for Girder Rails in Brooklyn (66756). R. C. Cram. Ills. 3500 w. El R Jl—Dec. 25, 1915. Advantages, especially the reduction of corrugation; details.

Review of 1915
Chief Features of 1915 Electric Railway Statistics (66870). 10000 w. El R Jl—Jan. 1, 1916. Summary of electric railway progress.

Signaling
Signaling a Large Interurban Railway (66300). Ills. 3000 w. Sg E—Dec., 1915. Automatic blocks and interlocking plants.

Skip Stops
Eliminated Stops in City Service (66871). 5600 w. El R Jl—Jan. 1, 1916. Schedule discussed by operators.

Utah
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EXPLANATORY NOTE—THE ENGINEERING INDEX

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REFERENCE LIST OF PUBLICATIONS REGULARLY REVIEWED AND INDEXED

ARRANGED IN ORDER OF THEIR ABBREVIATIONS

A A	Aerial Age
A & B	Architecture & Building
A A P C M	Assn. Amer. Portland Cement Mfrs.
Acr	Autocar
A El S	American Electrochemical Society
A E R	American Economic Review
Aern	Aeronautics
A E S	Assn. Engineering Societies
A F A	Amer. Foundrymen's Assn.
A I & S I	Amer. Iron & Steel Institute
A I C E	Amer. Institute of Chemical Engineers
A I E E	Amer. Institute of Elec Engineers
A I M E	Amer. Institute of Mining Engineers
A I Mt	Amer. Institute of Metals
A J l P H	Amer. Journal of Public Health
A J l S	Amer. Journal of Science
A M S	Australian Mining Standard
A R	Architectural Record.
A R B A	Amer. Road Builders' Assn.
A R E A	Amer. Ry. Engineering Assn.
A S	Applied Science
A S C E	Amer. Soc. of Civil Engineers
A S H V E	Amer. Soc. of Heat. & Vent. Engineers
A S M D	Amer. Soc. of Marine Draftsmen
A S M E	Amer. Soc. of Mechanical Engineers
A S N E	Amer. Soc. of Naval Engineers
A R C A O	Assn. of Trans. & Car Acct. Officers
Au-R	Automobil-Rundschau
Aut	Automobile
A W A	Amer. Water Works Assn.
B C Bul	Barge Canal Bulletin
B E C	Brooklyn Engineers' Club
B F & S P	Blast Furnace & Steel Plant
Bkbld	Brickbuilder
B M	Boiler Maker
B S C E	Boston Soc. of Civil Engineers
B u E	Beton und Eisen
B W	Brass World & Platers' Guide
C A M	Compressed Air Magazine
C-C A	Concrete-Cement Age
C C E	Cornell Civil Engineer
C D M	Canada Department of Mines
C E S	Cleveland Engineering Soc.
C G	Colliery Guardian
C I A At	Atti, Colleg. Ingegneri ed Arch.
Cl A	Coal Age
C M I	Canadian Mining Institute
C M Jl	Canadian Mining Journal
C M M S S A	Chem., Met., & Min. Soc. of South Af.
C M W A	Chamber of Mines of West. Australia
Cn E	Canadian Engineer
Cnr	Contractor
C R C	Central Railway Club
C S C E	Canadian Soc. of Civil Engineers
C S M M	Colorado School of Mines Magazine
C U Q	Columbia University Quarterly
C V	Commercial Vehicle
Cw E	Commonwealth Engineer
D W P B	Dominion Water Pow. Branch, Dept. Int.
E & C	Engineering & Contracting
E & M J	Engineering & Mining Journal
E C	Engineering Contractor
E C D	Engineers' Club of Dayton
E C P	Engineers' Club of Philadelphia
E G	Economic Geology
E K u B	Elektrische Kraftbetriebe und Bahnen
El A	Electrical Age
El Jl	Electric Journal
Eln	Electrician
El R	Electrical Review
El R & W E	Electrical Review & West. Elec'n
El R Jl	Electric Railway Journal
El T	Electric Traction
El W	Electrical World
E M	The Engineering Magazine
E N	Engineering News
Eng	Engineering
Enr	Engineer
E R	Engineering Record
E Ru	Elektrotechnische Rundschau

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E S P	Engineers' Soc. of Pennsylvania
E S W P	Engineers' Soc., West. Pennsylvania
E u M	Elektrotechnik und Maschinenbau
E Z	Elektrochemische Zeitschrift
Feuer	Feuerungstechnik
F I	Franklin Institute
Fnd	Foundry
G A	Gas Age
G A G B	Glaser's Ann. für Gewerbe u Bauwesen
G E R	General Electric Review
G-I	Gesundheits-Ingenieur
Glk	Glückauf
Gn Cv	Génie Civil
G R	Good Roads
G W	Gas World
G-Z	Giesserei-Zeitung
H A	Horseless Age
H & V M	Heating & Ventilating Magazine
I A	Iron Age
I An	Anales de Ingenieria
I & C T R	Iron & Coal Trades Review
I & R	Ice & Refrigeration
I C E I	Inst'n, Civ. Engineers of Ireland
I C E	Institution of Civil Engineers
I E	Industrial Engineering
I E E	Institution of Electrical Engineers
I E S S	Instn, Engrs. & Shpbldrs of Scot.
I F	L'Ingegneria Ferroviaria
I I Bul	Bulletin of the Imperial Institute
I Mch E	Institution of Mechanical Engineers
I M E	Institution of Mining Engineers
I M M	Institution of Mining & Metallurgy
I Mr E	International Marine Engineering
Ind	L'Industria
Ing	Ingenieur
I S C A M A	Iowa State Col. of Agri. & Mech. Arts
I S E	Institute of Sanitary Engineers
I T R	Iron Trade Review
Jl Act	Journal of Accountancy
Jl G	Journal of Geology
K A E	Keighly Assn. of Engineers
La Nt	La Nature
L S M I	Lake Superior Mining Institute
M A E	Manchester Assn. of Engineers
M & C E	Metallurgical & Chemical Engineering
M & E R	Mining & Engineering Review
M & E W	Mining & Engineering World
M & S P	Mining & Scientific Press
M B M A	Master Boiler Makers' Assn.
Mch	Machinery
Mch E	Mechanical Engineer
Mch W	Mechanical World
M E & N A	Marine Engineer & Naval Architect
M I	Metal Industry
M Jl	Mining Journal
M Mg	Mining Magazine
M M S A	Mining & Metallurgical Soc. of Amer.
M R	Montanistische Rundschau
M Rd	Manufacturers' Record
M Rv	Marine Review
M T	Monitore Tecnico
Mun E	Municipal Engineering
Mun Jl	Municipal Journal
N E	National Engineer
N E C I E S	N-E Coast Instn., Engrs. & Shpbldrs.
N E W W A	New England Water Works Assn.
N F A Sf Bul	National Founders' Assn. Saf. Bulletin
N G M	National Geographic Magazine
N L M A	National Lime Manufacturers' Assn.
Nt	Nature
N Y R C	New York Railroad Club
O S M E S E	Ohio Soc., Mech., Elec. & Steam Engrs.
P B S	Philippine Bureau of Science
P C An	Annales des Ponts et Chaussées
P E, C	Practical Engineer, Chicago
P Jl S	Philippine Journal of Science
P R	Polytechnische Rundschau
P-W I	Permanent-Way Institution
Pwr	Power
Q G M Jl	Queensland Government Mining Journal
Qry	Quarry
R A G	Railway Age Gazette
R & L E	Railway & Locomotive Engineering
R C P	Railway Club of Pittsburgh
R E	Railway Engineer
R E & M W	Railway Engineering & Maint. of Way
R G	Railway Gazette
R G S	Revue générale des Sciences
R M	Rivista Marittima
R M E	Railway Mechanical Engineer
R Met	Revue de Métallurgie
R M M	Railway Master Mechanic
R R	Railway Review
R S A	Royal Society of Arts
R S E	Railway Signal Engineer
R T	Resources of Tennessee
R T C	Revue Trimestrielle Canadienne
R U S I	Royal United Service Institution
S A	Scientific American
S A E	Society of Automobile Engineers
S & I	Steel & Iron
S & S-W R C	Southern & Southwestern Ry. Club
S A S	Scientific American Supplement
S B	Schweizerische Bauzeitung
S C A An	Anales de la Soc. Cientif. Argentina
Sch	Schiffbau
S C I Rv	Revista, Soc. Cubana de Ingenieros
S E	Society of Engineers
S E I N	Société d'Encourag., Indus. Nation.
Sf E	Safety Engineering
S I	Stevens Indicator
S I A I An	Annali, Soc., Ingeg. e Archit. Ital.
S I C F	Société, Ingenieurs Civils de France
S I E	Société Internation. Électriciens
S Jl E	Sibley Journal of Engineering
S L R C	St. Louis Railway Club
S M	Scientific Monthly
S M C E	Surveyor & Municip. & County Engr.
S M Q	School of Mines Quarterly
S N A M E	Soc., Naval Arch. & Mar. Engineers
S P S M	Soc. to Promote Sci. of Management
S R & M E	Sanitary Rec. & Municip. Engineer
St u E	Stahl und Eisen
T & R W	Tramway & Railway World
T E	Telephone Engineer
T E A	Traveling Engineers' Assn.
Tly	Telephony
T S	Travelers Standard
T T	Teniente Topics
T u W	Technik und Wirtschaft
U E E S	Utah Engineering Experiment Station
U I	University of Illinois
U M	University of Minnesota
U M S M M	Univ. of Mo. School of Min. & Metall.
U N P	Universidad Nacional de la Plata
U S B M	U. S. Bureau of Mines
U S B S	U. S. Bureau of Standards
U S C & G S	U. S. Coast & Geodetic Survey
U S D A	U. S. Dept. of Agriculture
U S G S	U. S. Geological Survey
U S N I	U. S. Naval Institute
W E	Western Engineering
W G N H S	Wis. Geol. & Nat. Hist. Surv.
Wis E	Wisconsin Engineer
W P I Jl	Jour. Worcester Polytech. Institute
W R C	Western Railway Club
Wrk	Werkzeugmaschine
W S E	Western Soc. of Engineers
Z g T	Zeitschrift, gesamte Turbinenwesen
Z V d I	Zeitschrift, Ver. deutsch. Ingenieure

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THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. L MARCH, 1916 No. 6

THE GREAT PAN AMERICAN OPPORTUNITY

By John Barrett

Director General of the Pan American Union, Washington, D. C., formerly United States Minister to Argentina, Panama, and Colombia.

Industrial managers the country over are looking for markets for the output of their plants. Europe is buying chiefly war supplies; and South America, a large purchaser of European goods, is turning to this country. Again, many materials formerly bought by us from Europe, we are now finding can be purchased in South America. Thus it is imperative that we leave no stone unturned in furthering the progress we have already made through the work of the Pan American Union, as pointed out by Dr. Barrett, and seek to establish an even closer community of interests.—THE EDITORS.

PAN AMERICANISM is the slogan of the hour. The whole Western Hemisphere is awakening, as at no time since the declaration of the Monroe Doctrine in 1823, to an appreciation of the importance of developing the closest Pan American relations not only of commerce and trade but of comity and friendship. The silver lining of the European war cloud is the influence which that mighty struggle is having upon the evolution of Pan American solidarity, and of Pan American unity of interest, action, and purpose. During the last two years the statesmen, the editors, and the people in general, of the twenty Latin American Republics have said more kind things about the government and the people of the United States than they have done before in a score of years. In return, the statesmen, the editors, and the interpreters of public opinion in the United States have shown more appreciation of, and interest in, the Latin American Republics than they have done before in the history of this country.

For many years the Pan American Union has been endeavoring to awaken the people of the United States to a knowledge of the value of the commerce and the friendship of the Republics which reach from Mexico and Cuba on the north to Argentina and Chile on the south. It has also striven to encourage throughout the southern nations a better ac-

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quaintance with the people and purposes of the United States. Although this work has borne fruit and has accomplished great results, as has been proved by the increase in trade, travel, and good understanding, the most powerful international influence to help inaugurate a new Pan American era has been the European war.

Inasmuch as I have just referred to the Pan American Union, and in view of the fact that the average manufacturer, exporter, importer, engineer, and banker is too much occupied with his own responsibilities to be intimately familiar with the real character, scope, and work of this organization, it is fitting that in passing some comment should be made upon what it is doing for Pan Americanism.

Defined in a sentence, the Pan American Union is the official international organization of the twenty-one American Republics—the United States and its twenty sister Republics —maintained by them in Washington through their joint contributions based upon population; controlled by a Governing Board consisting of the Latin American Diplomatic representatives and the Secretary of State of the United States; devoted to the development of commerce, friendship, good understanding, and peace among them all; and administered by a Director General, elected by this Board, who in turn is assisted by an expert staff of statisticians, editors, compilers, librarians, translators, etc. Its annual budget amounts to about one hundred and fifty thousand dollars, and it occupies buildings and grounds representing an investment of one million one hundred thousand dollars. Its beautiful home in Washington, at the foot of Seventeenth Street near the entrance to Potomac Park and only a stone's throw from the White House, has been described as the "capitol" of the Western Hemisphere in the national capital of the United States. This building holds a unique position among the beautiful structures of the world. A great French architect has commented upon it as "combining beauty of architecture and usefulness of purpose for its cost more than any other public building in the United States."

Although the Pan American Union was first organized in 1890 as a result of the First Pan American Conference presided over by James G. Blaine, then Secretary of State, it did not fully evolve into a great international organization until after the Third Pan American Conference, which was held at Rio de Janeiro in 1906, and which was attended by Elihu Root, then Secretary of State of the United States. Since that date when it was reorganized, it has been international in every respect, with each one of the twenty-one American Republics having an equal voice in its direction. Its Director General is in truth not an officer of the United States alone, appointed only by the President of the United States, but he is an officer of all the American Governments appointed, so to speak, by all of their Presidents expressing their ballot through their representatives in Washington.

Viewed on the practical side, the Pan American Union conducts an enormous correspondence with all parts of the world, providing every variety of information concerning each of the American nations. It publishes a monthly bulletin with English, Spanish, Portuguese, and French editions, for which there is a greater demand than there is supply. This bulletin is a high class illustrated magazine, faithfully reporting and describing the progress of Pan America. The Union also publishes special descriptive pamphlets

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regarding each one of its constituent countries, and many other reports of a commercial and statistical character. It has a library of over thirty thousand volumes, which is rated as the best up-to-date collection of practical Americana. It also has a large collection of maps, directories, government official reports of each land, and over sixteen thousand photographs illustrative of every city and section of Latin America. The best evidence that the Pan American Union has been of use to the material interests of the Western Hemisphere is that, since it was reorganized or since the present executive officers took charge, the foreign trade of Latin America has nearly doubled, while the exchange of commerce between the United States and its twenty sister Republics has grown by almost an equal proportion.

Coming now to a direct consideration of the mighty Pan American field, it is highly important to look at it in a practical way so that it may seem real and not imaginary. The twenty countries lying south of the United States cover an area of approximately 8,500,000 square miles; they have a population of nearly 80,000,000; and they conducted in the last normal year before the war, 1913, a foreign commerce valued at about $3,000,000,000.

In studying these countries as a whole they should be classed as "Latin America" and not "Spanish America," because the latter term would omit Brazil which is of Portuguese extraction and which occupies more than one-third of the total area of Latin America. It must always be borne in mind, however, that each one of these countries values its individuality, and the man from Argentina, Chile, Bolivia, Peru, Colombia, Venezuela, and Cuba never wants to be known as a "Spaniard" but as an "Argentine," a "Chilean," a "Bolivian," a "Peruvian," a "Colombian," a "Venezuelan," or a "Cuban" as the case may be. Glancing, moreover, at all of these countries, we would not segregate them and lump them together as if they were all alike, any more than we would lump together as being similar in national and racial characteristics the peoples and the countries of Europe and Asia. There is a wide divergence in customs, habits, progress, and prosperity, and even in characteristics among the peoples, countries, and sections of Latin America. Only by a realization of the individual features, tendencies, history, and ambitions of each land can a North American learn to understand well the countries and peoples of Latin America.

In order to have the right grasp not only of the commerce but of the relationship of the countries of Latin America, it is necessary to divide them into different groups. The first general segregation is that of the twelve countries bordering upon the Gulf of Mexico and the Caribbean Sea, including, however, Salvador which has a coast only upon the Pacific Ocean. In this group are Mexico, Guatemala, Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Venezuela, the Dominican Republic, Haiti, and Cuba. All of these have a much closer relationship to the United States in commerce, travel and intercourse than have the other countries of Latin America. The most remote point on the Gulf and Caribbean Sea Coast of any of these countries is not distant more than 1,800 miles from an average point on the southern coast of the United States. These twelve nations in the last calendar year before the war, 1913, conducted a foreign commerce that was valued at approxi-

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mately $800,000,000, and that in turn represented an increase of nearly 100 per cent during the last ten years, or since they began to feel the new life resulting from work on the Panama Canal, the opening of which will place them upon a world route of trade and travel. They have a combined population of nearly 34,000,000, and they cover an area of nearly 2,000,000 square miles, which is equal to two-thirds of the area of the United States. No one can measure the vast potentialities of the trade of these countries, now that they are being developed by United States capital and are being made accessible by excellent steamship facilities. The travel back and forth of their peoples and those of the United States has increased nearly 300 per cent during the last decade. The foreign trade of this group, moreover, is very largely with the United States and in only one of these countries, namely Guatemala, in 1913, did any European country have a larger share than that of the United States.

The next group is that of the five countries of South America which are tributary to its western or Pacific Coast. These include the Pacific section of Colombia, all of Ecuador, Peru, and Chile, and Bolivia which, though it has no coast line, carries on its commerce through the ports of Peru and Chile. These countries conducted in 1913 a foreign commerce valued at approximately $500,000,000, which, in turn, showed a great increase over ten years ago. In this the share of Europe was a little larger than that of the United States, but now that the Panama Canal is about to be opened the indications are that the commerce of the United States will grow rapidly and should offer splendid opportunities for the manufacturers, exporters, and importers of North America. Their population exceeds 15,000,000 and awaits an incoming immigration from Europe and the United States which will help them to realize the prosperous future to which they are destined because of their natural resources. The average man who has not visited the interior but who has only traveled by sea up and down this western coast thinks it is barren and without promise, but those of us who have traveled thousands of miles through the valleys and over the plateaus of the Andes believe that they will enjoy a progress in the future equal to that which has characterized the growth of California, Oregon, and Washington pon the Pacific Coast of the United States. That these countries must have vast potential resources is confirmed by the fact that they cover an area of mountain, valley, plateau, and lowlands exceeding 1,500,000 square miles, or more than half the area of the United States proper.

We now come to the largest and the richest section of Latin America or that which is tributary to the eastern and southeastern coast of South America on the Atlantic Ocean. In this group are included Brazil, Paraguay, Uruguay, and Argentina, with an annual commerce of $1,650,000,000, a population of 35,000,000, and an area of nearly 4,600,000 square miles, which could include all of Europe and half of the United States.

To grasp the true Pan American situation and to form a right idea of the Latin American field of commerce and friendship, it is necessary to destroy one or two bogies that seem to continue looming up before the manufacturer, the exporter, the importer, the banker, and the engineer of the United States, who has not thoroughly familiarized himself with the field. The first bogey is that

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of revolutions. The average man holds the six pence of prejudice, fashioned out of the situation in Mexico, so near his eye that he does not see the great peaceful area and peoples beyond. The truth is that two-thirds of the area and population of Latin America have known no revolutions whatever during the last quarter of a century, and the indications are that a great majority of the countries are entering upon an undisturbed era of progress. In this connection it is interesting to note that there have been five times more international wars in Europe during the last one hundred years than there have been in Latin America.

The next bogey that I enjoy destroying is that the commerce of the United States with Latin America has been neglected and that this country is far behind Great Britain and Germany in what it has accomplished. Although it is to be admitted that the commercial and financial interests of the United States as a whole have not appreciated Latin America and have not made the effort which should have characterized them, a large element of the manufacturers, exporters, importers, and financiers of the United States deserve special credit for what they have accomplished in, and for the attention which they have given to, Latin America. There is nothing which is more untrue and discouraging than to listen to the superficial student or observer who cries out that the United States has done nothing in Latin America and is to be condemned for this situation. Let us see what are the real facts and figures, for they cannot be controverted. In 1913, the last regular uniform year before the war broke out, the total commerce of the United States with Latin America—that is both exports and imports, exceeded $800,000,000, which, in turn, represent an increase of fully 100 per cent during the last ten or fifteen years. The total commerce of Great Britain with all Latin America, which has been so much flaunted, approximated $650,000,000, or nearly $150,000,000 less than that of the United States! The total commerce of Germany, of which we have heard so much, approximated only $410,000,000, or about one-half that of the United States! In the light of these figures American business men should take courage, rather than be discouraged by the common talk of the uninformed man. It is true that in a few of the Latin American countries Great Britain and Germany have outdistanced the United States, but that is due to the fact that they were well established there long before the United States began its campaign for trade. If with the added help of the European war the commercial and financial interests of the United States will continue to make the same effort during the next few years that they made during the last five years before the war, *there is no question whatever that they will become the leaders in the foreign commerce of each and every country of Latin America as they are now in all Latin America!*

The final bogey that I wish to destroy is that the Latin American peoples hate or distrust the peoples of the United States. Basing my conclusions on nearly fifteen years intimate study of Latin American governments and peoples, first, during my experience as United States Minister in Argentina, Panama, and Colombia, and secondly, during my administration of the office of the Director General of the Pan American Union, I would emphatically state that this so-called hatred or distrust exists only upon the surface and

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among only a limited number of men. My judgment in this respect will be confirmed by such authorities on the part of the United States as Elihu Root, Robert Bacon, Theodore Burton, L. S. Rowe, William R. Shepherd, and a long list of United States Ambassadors, Ministers, and Consuls who have spent many years in Latin America, and, on the part of Latin America, by such representative men as their Ambassadors and Ministers in Washington and the editors of most of their great newspapers. In Latin America there are demagogues, sensational writers, and notoriety-seeking lecturers who love to inveigh against the United States and whose comments often appear in their papers. These sentiments, which do not excite much attention to Latin America, are copied in turn by the press of the United States, and the people here draw the conclusion that these views represent the underlying sentiment of Latin America. This conclusion is no more just than to interpret the sentiment of the United States towards foreign countries from the sensational press reports, and speeches of its demagogues and publicity-seeking lecturers who are incited more by love of advertisement than by truth-telling. There is in different countries of Latin America a certain measure of well-merited criticism of the United States and its people, based upon the acts of individuals and upon the words of some of its statesmen and writers, but this should not be interpreted as a deep seated distrust or hatred.

If the average commercial and financial man of the United States will study Latin America and familiarize himself with the history, the geography, the resources, the progress and the possibilities of each country with which he conducts transactions, he will soon find that he is not only welcome but well treated, and that there are in most of these countries splendid opportunities for the building up of his trade and for the investment of his capital. He must, however, not expect special favors which he could not get in the United States, or concessions which are not entirely in his favor and not considerate of the country itself or of its people. Too many Americans expect to be treated more favorably in Latin America than they are in the United States and in Europe or even Asia. It is true that there are difficulties in the way, such as peculiar laws, severe tariff and mining regulations, poor facilities for transportation in some sections, and bad climatic influences in other sections, but, viewed as a whole, Latin America offers a field which is more inviting than it is discouraging and which compares most favorably with the early conditions that existed in Europe and Asia and even in the western section of the United States.

It should not for a moment be thought, however, that any portion of Latin America is an El Dorado. This idea has gained some credence among superficial observers, but it is due to their own conclusions and not to the facts which are published by the Latin American governments, by the Pan American Union, or by the Department of Commerce of the United States. No man can expect to pick up gold nuggets or "get rich quick" in a Latin American country any more than he can in an individual state of the United States. But if he will go about things in a reasonable, wholesome, and honest way, the chances are nine in ten that his efforts will not be in vain.

Probably there is no influence that militates more against the average man of the United States who wants

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to do business in Latin America than his ignorance of the countries and peoples, of their geography and resources, of their history, and of their customs and habits. It will not be until this ignorance is supplanted by real practical knowledge that the best results can be realized. It is of the highest importance, therefore, that throughout the United States, not only in commercial and financial organizations but in labor organizations, in universities, in colleges, in public schools, and in all kinds of clubs which discuss questions of general welfare, there should be inaugurated what might be termed *a Pan American movement* which will inspire the great majority of our people to get better acquainted with Latin America as a whole and with each Latin American country viewed individually. There should be encouraged, moreover, in our schools the study of the Spanish and Portuguese languages. A knowledge of these is a powerful factor in building up both commerce and confidence. Already, as a result of the efforts of the Pan American Union, over two thousand educational institutions in the United States have taken up the study of the Spanish and Portuguese languages and of Latin American history and geography. Correspondingly, it is to be hoped that throughout Latin America there will be a more intimate study of the United States, of its characteristics, its possibilities, its people, and of its language.

We require, moreover, a much greater exchange of travel. Travel is a powerful factor in acquaintance, and acquaintance is a direct influence in the building up of trade and good understanding.

Possibly there is no greater need of the hour in the promotion of Pan American relations than that of increasing investment of United States capital in each and all of the Latin American countries. Before the European war broke out the governments and private enterprises of these twenty countries placed nearly all of their loans with European financiers. The war has put an end to that source of supply and it will be many years before they will again be able to furnish money to Latin America. It is, therefore, absolutely necessary for the bankers, the financiers and the bond-buying element of the United States to meet the situation and show a practical spirit of co-operation for the benefit of our sister Republics. It is just as necessary for these countries to have money in working out their material and political progress as it has been for the United States, as a whole, and its individual states to have money for their development. If the financial interests of the United States do not respond to this need, they will have only themselves to blame if, during the next ten years, Europe recovers the trade and position which she has lost through the war. It is my firm conviction that if the bankers and financial leaders of the United States will loan $1,000,000,000, or $100,000,000 a year to Latin America for the next decade, they will be rewarded by an increase of a billion dollars in the exchange of trade between the United States and these countries. A careful study of the evolution of Latin American governments, material enterprises, and prosperity shows that the commerce of European countries has grown most rapidly in the lands of Latin America where they have invested the most capital.

It is not easy to measure the opportunities in all parts of Latin America which await United States capital. The opening up of rich in-

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teriors with railway construction, the harnessing of numerous water powers, the bringing to the surface of vast mineral wealth, the marketing of the valuable timbers of the immense forests, the extension of irrigation from the stored waters of the Andes, the improvement of agricultural methods, the mastering of the jungle through modern sanitary processes as exemplified at Panama, the improvement of harbors and ports, and the utilization in a thousand ways of the resources of Latin America, provide opportunities for United States capital equal to those which it has had in the United States during the last fifty years.

Let the American financial interests meet the situation in the right way without overcharging for the money invested or without acting as if they expected to get all the advantages, and there will come a change which will have a profound influence upon Pan American friendship as well as on Pan American commerce.

It is not necessary for me here to enlarge upon the necessity of developing to the highest degree of efficiency an improved steamship service. It will be absolutely impossible for United States commercial and financial interests to take advantage of the opportunities offered, and for Latin Americans, in turn, to take advantage of their co-operation, unless there are worked out and made permanent the best steamship connections between the principal ports on the Atlantic, Gulf, and Pacific Coasts of the United States on the one hand, and the representative ports of the Pacific and Atlantic Coast lines of Latin America. There is a demand for this on the part of Latin America just as much as there is on the part of the United States, and there is no question but that the Latin American governments will be willing to do their share with the United States government in the improvement of these facilities. There has been great progress already made, especially in the Gulf and Caribbean service, and, to some extent, between the Atlantic ports of the United States and those of the corresponding section of Latin America, but the latter is still capable of additions in passenger and freight vessels which are much needed, while upon the western coast of South America there can be a decided change for the better.

Another great necessity is that of the establishment in all parts of Latin America of banks controlled by United States capital. The wise initiative in this direction which has already been taken by the National City Bank of New York has proved the truth of this contention. This institution has made a decided success of its experiment in Buenos Aires and Rio de Janeiro, and there is no reason why the great banking institutions of other sections of the United States, especially of the Central West and Pacific Coast, should not inaugurate similar enterprises. There is room in Latin America for additional banking facilities, and it is probable that the National City Bank of New York would be no more antagonistic to such extension than they are to the building up of other banks in the United States.

It is not possible for me, in the limitations of space which must characterize an article of this kind, to touch more than a few of the high places in the commercial relations of the United States with its sister American Republics, but, if what I have written here excites a desire for more information, I hope that the reader will not hesitate to get in touch not only with the Pan American Union but with the Bureau of Foreign and Domestic Commerce of

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the Department of Commerce in Washington and also with the Chamber of Commerce of the United States, which are endeavoring in every way they can to promote Pan American trade. Especially would it be desirable for the person seeking further information to secure a list of the publications of these offices and then order such publications as appeal to his interest.

In conclusion I cannot withhold the opportunity which this article offers of impressing upon the highly intelligent constituency of THE ENGINEERING MAGAZINE the desirability of their interest in helping along the mighty Pan American movement which has received such an impetus recently not only from the European war but from the Pan American Financial Conference which was held in Washington in May, 1915, and more recently from the Pan American Scientific Congress, which assembled in the national capital in December, 1915 and January, 1916. This latter gathering was in some respects one of the most remarkable international congresses which has been held in the history of the world. It was the largest international assembly which has met in the national capital at Washington, and the largest Pan American conclave which has come together in the history of the Western Hemisphere. There were present nearly 200 actual delegates from the twenty Latin American countries, aside from the United States official delegation of twenty-one representative men and nearly one thousand unofficial delegates. It was divided into nine general sections which in turn were divided into forty-five sub-sections. For over two weeks this Congress was in session and its meetings were characterized with harmony, good feeling and enthusiasm. It presented, by its united association of all the American Republics, a mighty contrast to the fighting nations of Europe and Asia.

While this Congress could not discuss political questions, there eminated from it an atmosphere and suggestion of Pan American solidarity, Pan American comity, and Pan American mutuality. There seemed to be an underlying thought that the present tendencies of the day are evolving the Monroe Dectrine into a Pan American Doctrine—that is to say, from a doctrine promulgated and supported alone by the United States to one promulgated and supported by all of the American republics. If there has been opposition in Latin America to the Monroe Doctrine in the past it has not been due to the doctrine itself so much as to the interpretation thereof. The Latin American countries and peoples rightfully object to any dictatorial attitude on the part of the United States as if it were both "papa" and "mama" and they were inferiors or children not yet of age. On the other hand, that interpretation of the Monroe Doctrine which means that each Latin American country would stand for the sovereignty and integrity of the United States and every other American Republic just as quickly as the United States itself would stand for the sovereignty and integrity of any American Republic, is the interpretation which will make it enduring and which will pave the way for the evolution of that kind of Pan Americanism which means that Pan America will be the triumphant force in the civilization and progress of the world.

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THE FUTURE OF THE STEEL INDUSTRY

By H. H. Campbell.

Many manufacturers are in desperate straits on account of the shortage of steel. If steel for industrial purposes is scarce now because of war orders, what will be the condition later? Mr. Campbell's forecast will prove interesting.—THE EDITORS.

WE would all like to know what is going to happen to the steel industry of Europe and America after the war, because then we would know what changes will take place in other lines of trade. In making this inquiry we may leave Norway, Denmark, Holland, Switzerland, Portugal, and the Balkan States out of consideration, since they produce hardly any steel or iron. We can omit both Spain and Sweden, since they are mainly exporters of iron ore; while Italy, Austria, and Russia make only enough steel for their own needs and take little part in the international iron trade. The problem therefore narrows itself to a discussion of the conditions surrounding the industry in Great Britain, Germany, France, and Belgium. These last three countries draw most of their iron ore from what is known as the Minette district, which was described by the writer in THE ENGINEERING MAGAZINE for November, 1914, and from this point of view they all have an equal chance for the trade of the world; but local conditions vary, so that we will say a word about each separately.

FRANCE

There is not enough coal in France to supply the needs of the country, hence, a large proportion of the fuel used in French blast furnaces must be brought from Belgium. A still greater handicap to the steel makers is the psychology of the French workmen; they will do artistic work and can make the best qualities of special steel, but they will not do a day's work at heavy tasks. Two years ago the very thought of a rapid automatic tool would have given them nervous prostration. This war, however, has aroused the French people from their lethargy, and in the future it is possible they will occupy as large a place in the world of industry as they now do in that of art.

BELGIUM

There is very little iron ore in Belgium, and almost all that is used is imported from French Lorraine and Luxemburg. The great advantage possessed by Belgian manufacturers is an abundant supply of cheap labor; whether they will have this after the war is a matter of opinion.

GERMANY

Germany has several deposits of coal and ore, but we need only consider here the beds of iron ore on the frontier of France and the coal fields of Westphalia on the lower Rhine, for these are the foundation stones of industrial Germany. It is rather hard to prophesy about the future, for we do not know whether Germany will retain the territory she now occupies, or whether German Lorraine will be taken by France. Germany now holds two-thirds of the ore mines, coal mines, blast furnaces, and steel works of France; also all the coal mines and iron and steel plants of Belgium, and, by virtue of the control of both Luxemburg and French Lorraine, possesses all the ore beds

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from which Belgian blast furnaces have been supplied. It is possible that when the war ends all this territory will be in the hands of one of the combatants, and then this one nation will be in a position to ruin the industries of its rivals, either by establishing export duties or by changing freight rates.

Great Britain

Great Britain possesses an abundance of coal, a resource that has been one of the most important factors in maintaining her industrial position. There are also large reserves of iron ore, but most of the mineral is of inferior quality and large amounts of better ore are imported from Spain, Sweden, Algeria, and other countries. It is from this imported ore that England makes a great part of her steel; but the reserves of ore in Spain will not last forever, and in anticipation of the failure of this foreign supply, Great Britain is turning more and more to her domestic ores.

Our Future Competitors

It has been shown that only Germany, Great Britain, and Belgium are important factors in the international iron trade. Of these, the latter has always exported a considerable quantity of steel, but only one-seventh that of Germany; so that, in broad terms, we may omit Belgium from this inquiry, and say that in the future the United States must compete with Germany and Great Britain for foreign trade.

Labor in Great Britain

We have considered thus far only natural advantages or disadvantages as evidenced by a supply of raw material and by the part the different nations have taken in the past in the trade of the world. Other conditions must be considered, and among these the labor question looms large.

Great Britain has always had highly skilled labor and at wages lower than prevail in this country. These lower wages have in the past made up for the fact that English workmen are unprogressive and contumacious, but during the last year the labor unions have taken advantage of the situation to obtain higher pay and have declared that after the war they propose to keep these wages, while at the same time they will insist on the restoration of the conditions existing two years ago regarding limitation of output and non-employment of unskilled laborers.

It has been suggested that the difficulty will be solved by the adoption of American automatic machines, but this will not answer the question, for it is useless to install a machine capable of making one hundred pieces a day if the labor unions decide that only ten pieces are to be made. There is no use buying a race horse to put into a tip cart. In consequence of the universal increase in wages in the last year, coal, iron ore, and all the elements entering into steel production will cost more after the war, and it will be difficult for England to compete with her trade rivals, unless British manufacturers can get rid of labor union domination.

Labor in Germany

Many German workmen have been educated in vocational schools, while most of them have served in the army. Whatever we may think of conscription, every German looks back on his term of military service as a period of physical and mental training, which has made him a better worker, or a better manager and a better citizen. In a German shop, men are not trying, like the English workmen, to see how little they can do, and they are probably the most efficient workmen in the world, for efficiency is not measured by the amount of work done in a day, but by the cost of a unit of production.

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The average output per man is less in German than in American shops owing to a smaller proportion of automatic tools, but the workmen do not get anywhere near the wages that are paid in this country.

Labor-Saving Machinery

A German manufacturer who is considering the introduction of labor-saving machinery does not ask the labor unions how many pieces a day are to be made, as must be done in England, but he has a different problem from his American competitors on account of the lower scale of wages. Let us take the simplest possible case and suppose that in an American shop there are two machines side by side, each tended by a man making $3 per day or $900 per year. If we can put in a machine which will enable one operator to do the work, and if we can buy such a machine for $2,000 it will be a good investment, for we will get the money back in less than three years.

Now suppose we have a similar situation in Germany, but that the men are only getting $1 a day or $300 a year. We are to invest $2,000, and we must allow for six per cent interest and ten per cent depreciation, so that the new equipment will cost a total of $320 a year for fixed charges alone, while we are saving only $300 a year. Moreover, if business gets slack these fixed charges will go on just the same, while with the former system of two operators, one man could have been laid off.

In Italy, Hungary, or Poland there is even less incentive to install labor-saving machines, for when labor can be had for fifty or seventy-five cents a day, there must be the promise of a radical increase in productive capacity to warrant spending money for new machinery; and, moreover, there must be a sufficient market to keep the new equipment busy. Therefore, European manufacturers must not be regarded as behind the times just because their shops are not equipped with the most modern tools; while the American manufacturer really does not have much advantage over them, because he is paying higher wages and is losing interest and depreciation on his investment.

In the foregoing discussion, machine tools have been taken as examples of labor-saving machinery, because the average reader will understand such an illustration better than references to rolling mills, but the principles involved are the same in all manufacturing operations. Our steel works have specialized and have introduced labor-saving machinery at great expense and we find it profitable to do this; in Europe it would not be economy, because the labor is so much cheaper, and because the demand for the output of any one article is more limited than with us. For instance, all the rails made in Belgium, including those for both steam and street railroads, for home use and for export, would not furnish work enough to keep one American rail mill busy. We must remember that there are more miles of railroad track in the United States than in all Europe.

Selling Methods

The Germans claim the right to sell surplus goods wherever they like and at whatever price they see fit, and our government has unwittingly furnished them with a strong argument in justification of this practice. Our Navy Department has made bids on the construction of new ships, stating that in making the estimates, the only items of overhead expense included were those which will be increased by the new work; since superintendence, repairs, and salaries

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will go on whether new ships are built or not.

Manufacturers everywhere can adopt this argument; for interest on bonds, depreciation, taxes, insurance, salaries, rents, and other overhead charges will be the same whether the plant runs or not; and it is good policy to keep the men working and to give them a living and to keep the organization intact by making goods for foreign markets, even though the selling price does not cover all these items. It will be difficult for our government to condemn the practices of the German manufacturers after this action of the Navy Department.

It is now proposed to protect American manufacturers by the imposition of a tariff, or some other means, from the competition of goods which are offered here below the home price, but it is not easy to see how this can help our manufacturers in competing for foreign trade. England and Germany must pay freight to send goods to New York, and our factories have this much protection; but in sending to South America we must pay an ocean freight at least equal to that paid by European countries; and we can not prevent them from selling goods below cost. Germany today is planning a campaign to capture the trade of the world, and it is difficult to see how we can compete with her under the restrictions which our government imposes.

Every manufacturer at some time has wished that he could make a sale in a foreign country at a price below that ruling at home, but he objects to relieving the pressure in the home market and standing all the loss himself. Germany has answered this problem, for a syndicate apportions both domestic and foreign orders; it may put one establishment on a foreign order where there will be no profit, but all the other works will pay their share of the loss just as they will participate in the benefits arising from the relief of the home market.

These syndicates are powerful weapons in securing foreign trade, and our government should lose no time in allowing American manufacturers to form combinations of this kind. Germany is, today, actually compelling every steel maker in the country to join a syndicate, while our government declines to permit anyone to form such an organization. It must be acknowledged that there are objections to allowing syndicates to control the home market, not only from considerations of public interest, but even from the viewpoint of the manufacturers themselves.

WAGES

It is possible that after this war there will be higher wages in Europe. This may arise from a depreciated currency, for this will raise the price of labor and of all other commodities; but it will not affect the selling price abroad, since foreign sales will be paid for on a gold basis.

An increase in the rate of wages may come about from a shortage in labor, but we must not forget that after our Civil War we did not experience any lessened supply of labor and that there was an era of unparalleled activity. We know that the steel works of Great Britain are running full today, while those in Germany are producing at about two-thirds of their capacity; which means that there is practically a full complement of men. In Belgium, we are told, the only reason the steel works are not in operation is because the workmen will not make material for the Germans, while their export business is cut off by the blockade.

In France, the steel works have been in possession of the enemy for more than a year and have been idle

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all that time; so that it may take several months to restore normal conditions at the close of the war. Germany has always employed a large number of foreigners as common laborers in their mines and factories. Two years ago there were nearly thirty thousand Poles and Italians at work in the Province of Lorraine alone, and the same conditions that brought this number can bring five times as many, although such a readjustment of labor conditions can not take place in a day.

It is conceded by everybody that if wages become higher, the cost of production will be increased. Of course, every manufacturer and every school boy knows that an increase in wages will increase the cost of the product, and strange though it may seem this has at last dawned upon our politicians. For years we have been told that high wages meant low costs, and while it is unfortunate that it took a European war to convince our statesmen of what everybody else knew, it will be worth the price if the elementary truths are understood by our Congressmen.

Reconstruction

The damage done in the war zone is almost all in a narrow strip of farming country, and nowhere in all Europe has a single steel works been injured, or indeed, very few factories of any kind. There has been some destruction of railway lines, but it is probable that the steel works of Europe could in a few weeks, if necessary, make enough rails and shapes to replace the tracks and bridges that have been destroyed.

The real work will be to replace miscellaneous equipment that has worn out, for locomotives, automobiles, machine tools, farm machinery, wagon tires, and sewing machines must all be bought in greater than normal amounts; not so much because such articles have been destroyed, as because replacements have not kept pace with wear and tear.

We must ask, on the other hand, whether the people will be able to buy all that they need. Many of our own homesteaders got along for years with the bare necessities of life, and many European peasants are accustomed to what we would call privation. We consider leather shoes a necessity, but millions of men and women in Europe prefer sabots. Our workmen ask for bath tubs, but the Belgians, French, and Italians would not use them if they had them.

General Conditions

There may be feverish activity in Europe after the close of the war, just as there was in this country after the Civil War; but there may be a period when everything is out of joint and prices will collapse. If there are hard times we may expect fierce competition from English and German works; for they must run and find a market and wages will come down in spite of any labor unions. The price of steel has often varied widely in a short period; thus in September, 1898, billets in the United States were quoted at $16; one year later they were $38; while in another twelve months they were $17. Nobody foretold these changes in our own country in times of peace, and nobody can tell what the conditions will be in Europe two years from now. We only know that if England and Germany can not find a market at home they will find a market here, if our Congress is foolish enough to permit them to do so.

While there are many other conditions which will influence trade, enough has been said to show that there are too many unknown quantities in the future of the steel industry to permit an exact prophecy.

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How to Increase Factory Efficiency

By O. M. Becker

I
Natural Lighting

Industrial managers may equip their shops with the most up-to-the-minute appliances; there may be no power losses between boiler room and machine shop; buying methods and selling methods may be perfect, but yet the plant may be inefficient because of inefficient workmen. This inefficiency may be due entirely to poor lighting, or poor ventilation, or poor sanitation, or lack of sufficient health-giving recreation, and these are the points Mr. Becker will discuss in this new series.—THE EDITORS.

ONLY of late has there been anything like a general recognition of the value of good lighting as a factor in production. Even careful students of industrial conditions have given scant attention to the subject; and owners (and all too frequently designers employed by them) whose concern it certainly should be to secure the best and most productive working conditions, appear to have been quite indifferent in this very important matter. It is not uncommon at the present time to find new factory plants going up, even when well situated, little or no better lighted than those built a generation ago. This is unfortunate for both owner and worker.

It is a well established physiological and psychological fact that gloomy surroundings have a depressing mental effect and reduce the physical efficiency of human beings. The natural consequence is reduced productive efficiency, and, therefore, loss to the employer. This reduced efficiency is quite aside from the losses arising directly from the same lack of sufficient light, through imperfect workmanship and wasted material, and the lowered *morale* of a working force so situated.

Furthermore, nothing is more certain than that dark shops are sure to be dirty and carelessly kept as compared with well lighted ones. Slovenliness naturally goes with gloom, which more or less hides filth and disorder; material is misplaced or lost; and the atmosphere of the place is distinctly unfavorable to efficiency. The most modern equipment, as an equipment merely, if operated under conditions precluding

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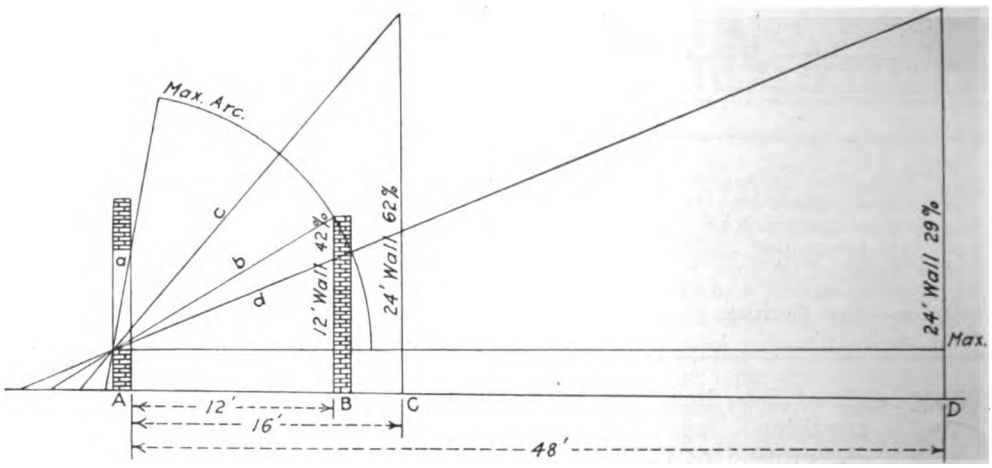
ample and well distributed light, loses somewhat, and not infrequently much, in its possible efficiency.

Another very important consideration is the relation of lighting to accidents. A great deal is being said, and done, with the purpose of reducing the appalling number of industrial accidents and injuries to work people. This is all very well. Apparently, however, it has not occurred to those interested in this subject that a very large percentage of all industrial accidents are due directly to bad lighting. Insufficient or bad light is rarely, if ever, mentioned as a cause, but anybody at all familiar with the facts is certain to be aware of the influence of such conditions, and of the relative freedom from accidents of properly lighted shops.

The cheapest as well as by far the best light is natural sunlight, tempered or diffused uniformly throughout the workshop. The first requisite for good lighting, therefore, is a sky exposure sufficient to insure ample light for all interiors, and a relatively large window area, such as to permit the proper utilization of the light.

Among competent designers the present practice in the design of industrial plants tends almost to go to extremes in this matter, at times overlooking certain other equally important considerations, like those affecting the strength of the buildings and their economical heating and ventilating. The use of steel and concrete for the framework makes it convenient to leave large openings for light. Indeed, it is coming to be quite common and is considered good construction to build multi-story factories with little or no wall surface, aside from the curtain walls necessary at and for some distance above floors. Obviously such liberal lighting is not feasible in the case of buildings of the mill construction and other types whose strength depends mainly upon the supporting walls.



HOW A WALL ADJACENT TO A WINDOW CUTS OFF THE LIGHT
The percentage of light obstructed is shown for several distances and heights of wall

The cost of twelve-inch wall and of glazing is practically the same, unless it is desirable to double glaze. This is not usually necessary if a strictly modern heating plant is installed, for in such case the cost of heating is practically *nil* anyway, exhaust steam being utilized for the purpose in one of several ways. If gas or electric power is used, and the heating cannot be accomplished by direct use of the waste heat, it raises

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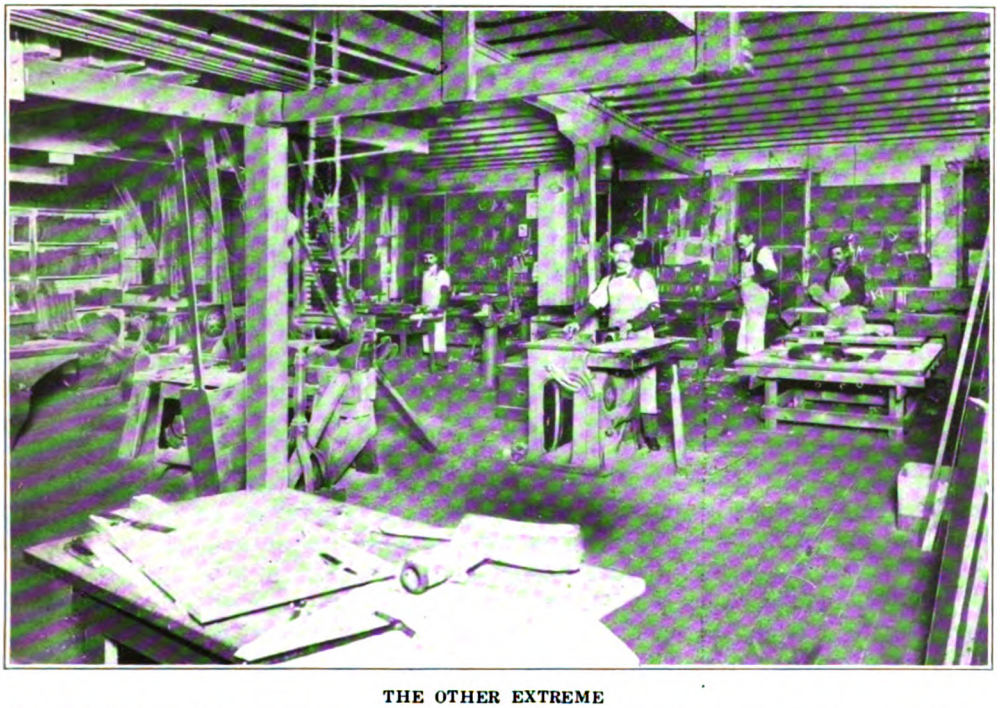
AN EXTREME IN THE DIRECTION OF PROVIDING AMPLE DAYLIGHT
West Albany Shop of the New York Central Railroad

the question as to which is the more economical—fixed charges on double glazing, or increased fuel cost: for the reduction of window surface below normal requirements for satisfactory lighting should not be considered.



THE OTHER EXTREME

In spite of a very long exposure this picture had to be strongly retouched in order to show any details at all. No argument is required to emphasize the slovenliness of such a room, the danger of accident, and the certain inefficiency of the workmen

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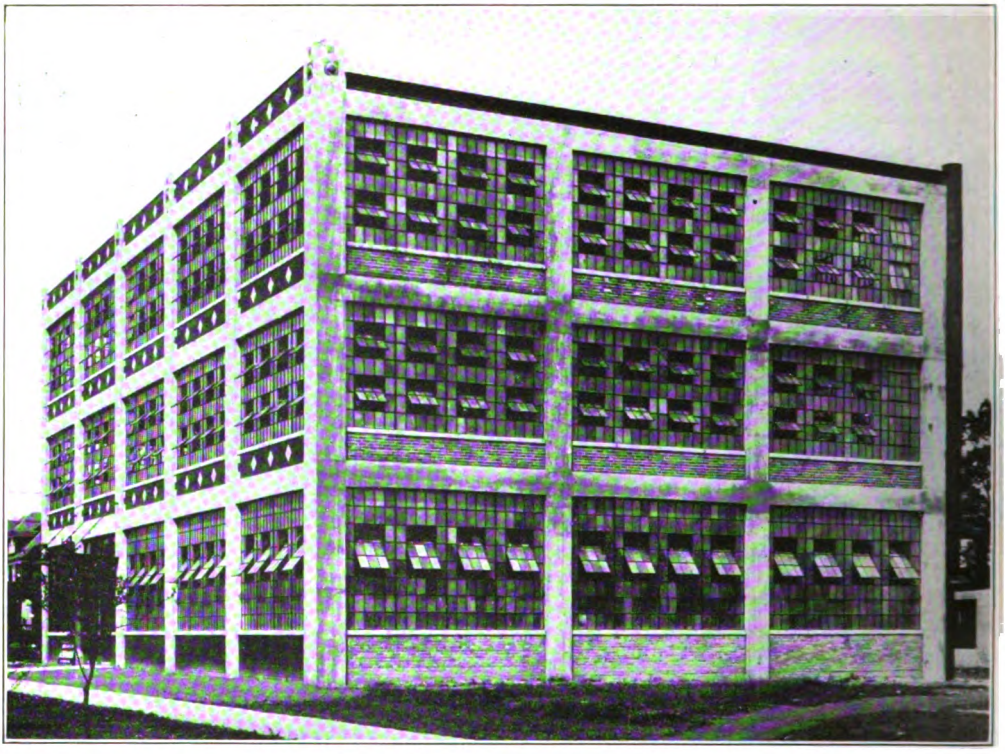

MULTI-STORY BUILDING OF REINFORCED CONCRETE AND BRICK WITH MAXIMUM LIGHTING SURFACE

This plant, Detroit Gear Grinding Machine Company, Detroit, is fitted with Fenestra ventilating sash and ribbed glass which diffuses the daylight evenly over the work rooms

The area necessary to produce satisfactory results will, of course, vary with conditions. In the case of buildings far enough away from others so that little or no light is cut off by the adjacent walls, the window area should be at least fifty per cent of the wall surface exposed to the interior, and it may well be as much as eighty. If part of the light is necessarily cut off by adjacent buildings, or if the floors be more than forty or fifty feet wide, the lighting area must be as great as is possible to provide. Extremely wide floors in multi-story buildings are difficult to light properly at the best, and are to be avoided for this reason as well as for considerations of safety in case of fire.

Practical experience has shown that for general manufacturing purposes a floor width of about sixty feet is, all things considered, most satisfactory in multi-story buildings. A floor of this width permits machinery to be arranged to good advantage and, if properly designed, also allows satisfactory lighting. In such buildings the stories should have twelve- to fifteen-foot ceilings, the windows reaching from ceiling to within three or four feet of the floor, the distance naturally depending upon the working conditions. In warehouses or other store rooms where less light is necessary than in work rooms, sufficient illumination usually may be secured by placing the window openings so as to reach from the ceiling to a distance from the floor such as will permit stacking material against the walls or the

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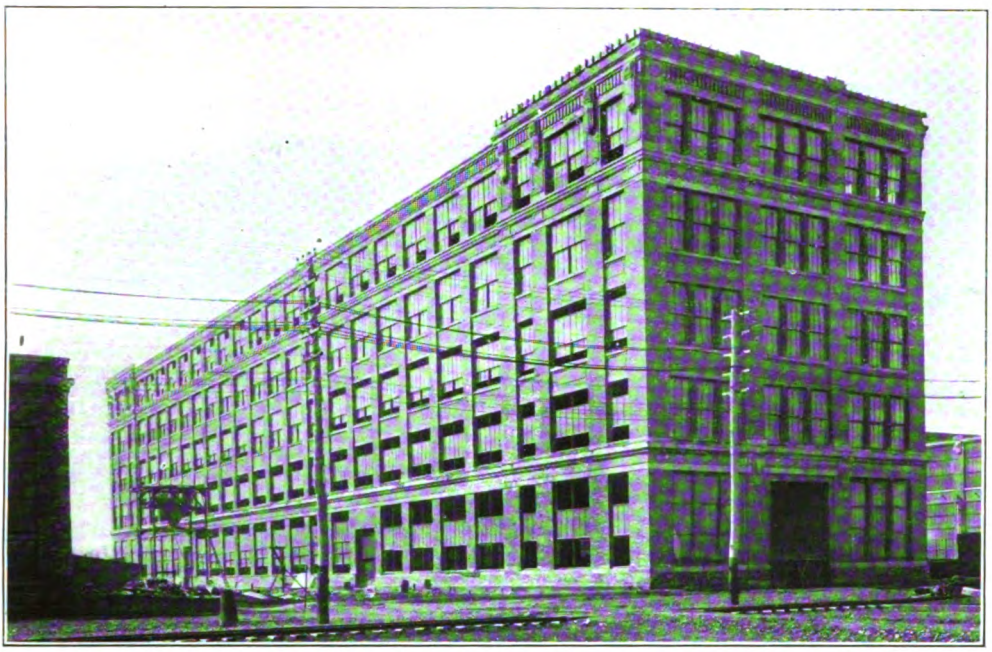

AN EFFICIENT FACTORY BUILDING, GENERAL ELECTRIC COMPANY, ERIE, PA.

This view illustrates the use of sliding steel sash in a modern industrial plant. Steel sash furnished by David Lupton's Sons Company, Philadelphia

placing of storage bins under the windows. Considerable space may sometimes be saved in this way.

Not only is the size of the window openings to be considered, but also the style and form of the sash. If the customary types are used, whether of wood or of pressed metal, it is necessary to make the openings considerably larger than if wrought steel sash are employed. The latter permit an influx of something like twenty per cent more light, and in several other respects also are very desirable. Their proved fire resisting qualities, for one thing, and the simplicity with which ventilation may be secured, especially commend this form of sash. There is no sticking, as in the case of wooden sliding sash or even of pressed metal or metal covered sash when fitted reasonably close.

The matter of ventilation is one that must be taken into consideration in connection with windows; for it is neither feasible, generally speaking, nor desirable in most instances, to depend throughout the year upon forced ventilation such as is secured by a suitable heating system. It is true that a heating and ventilating system could be used to advantage during the warm season or in climates where warming is unnecessary. In some cases, no doubt, such a system, probably in connection with a humidifying apparatus, is very desirable or even necessary; and so-called "natural" ventilation may be made to serve the purpose more or less completely. In the main, however, it still remains true that ventilation during the warm seasons must be obtained largely through use of the windows. The necessity for a sufficiency of movable sash to secure this end is evident.

Pivoted sash, whether the swing be horizontal or vertical, are preferable

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VIEW OF THE GENERAL ELECTRIC WORKS, ERIE, PENNSYLVANIA

to the sliding. They are mechanically simpler and therefore less expensive; and have the advantage of being easily operated, either individually or collectively, by mechanical devices installed for the purpose. A whole length of a room may have all or a given part of its pivoted sash swung by the turn of a wheel.

The glazing and care of windows do not usually receive the attention they deserve. No matter how much window space there may be, unless some method is employed for diffusing the light in rooms of any considerable depth, the illumination will be uneven. The spaces farthest from the window openings will be in comparative obscurity, while near the windows the light may be quite blinding. Where shops are wide enough to avoid the ill effects of the cross lighting, and in all cases where care is taken to prevent it, both side walls should by all means be provided with windows. In any case, provision should be made for an even diffusion of the light. Where direct undiffused light enters from more than one direction, the cavernous depths of the shops are penetrated by interfering walls of light. The effects of such cross lighting is disagreeable.

The prejudice against cross lighting, that is, the interference of light entering a room from different directions, is justified only where diffusion does not take place. Intense lights from different directions make it more difficult to avoid their blinding effects upon the eye, and they introduce distorted shadows, unnatural effects, and unnecessary eye fatigue. With the light diffused, the effect is like that of daylight when the sun is behind thin clouds.

Speaking in a general way, the illumination at the center of a room of moderate size, whose natural light is properly diffused, is at least three times that where ordinary transparent glazing is used alone. No shades are necessary with suitable diffusing glass. Shades at the best have the effect of reducing the effective illuminating area; and taking maintenance into consideration they are no cheaper than proper glazing.

Diffusion, that is, even distribution of light, is accomplished through the use of ribbed, prismatic, or maze glass, which prevent the direct transmission of light—that is, glass which is translucent merely, and not transparent. Fabric compounds are also used for this purpose, but they seem to be of doubtful value. There is much difference in the diffusing effect of the various forms of glass intended for this purpose. Any glass with a roughened surface will give some diffusion, which is nothing but the dispersion of light rays in all or in determined directions instead of

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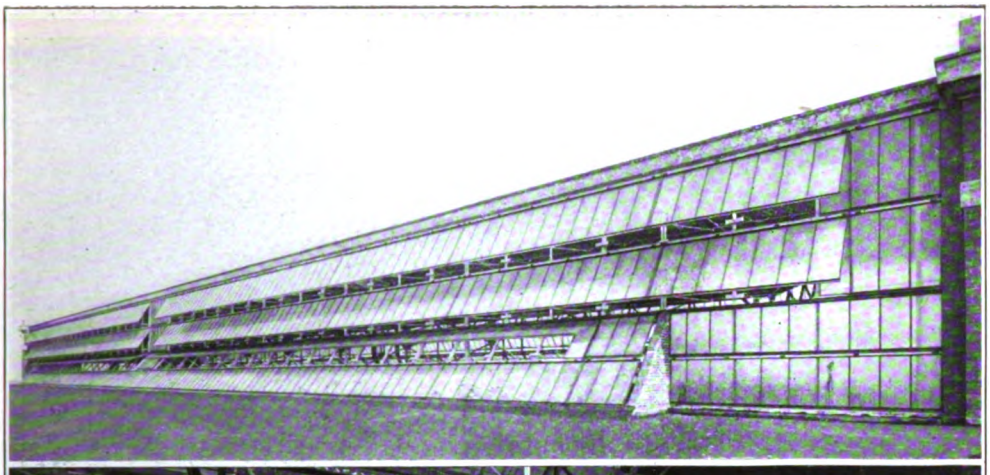

EXTERIOR AND INTERIOR VIEWS OF THE PLANT ILLUSTRATED ON PAGE 840

Views of the malleable iron foundry. This building is 400 feet long and 415 feet wide. The construction shows Pond continuous sash on Pond trusses. The sashes are provided with strong panels and are easily cleaned from the roof. Even distribution of light and ventilation is provided throughout the entire room. David Lupton's Sons Company, Philadelphia

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GOOD AND BAD LIGHTING IN THE SAME BUILDING

The upper view shows one of the floors of the Studebaker building, South Bend, Indiana, fitted with wood sash and plain sash; the lower view shows another floor in the same building fitted with Fenestra steel sash and diffusing glass

permitting them to pass directly on as they would when coming through smooth and transparent glass. But only a glass, one of whose surfaces is virtually a series of parallel prisms so arranged as to direct a large proportion of the rays in planes nearly parallel with the floor and ceiling, can equalize the illumination of parts near to and those remote from the source of illumination. Ground glass intercepts so much light that it is undesirable. Ribbed glass set with the ribs horizontal accomplishes the pur-

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GOOD LIGHTING BUT IMPROPERLY USED

In this plant there is plenty of window space and ceiling height, but because of the improper diffusion of light many deep shadows result. The women working at the side of the room are obliged to face the glaring sunlight. Substituting light diffusing glass the glare would be removed and better distribution obtained

pose very well, and prism glass does it better. Where the rooms are very wide, the latter is most likely to be satisfactory.

Maze glass, by which is meant any translucent glass with a figured surface, breaks up light rays and disperses them more effectively than any other kind; but as the diffusion is in all directions, the penetration is diminished, and it is not possible to get light from windows so glazed far into deep rooms. Its best use is for windows in comparatively narrow buildings, and to get from windows more or less exposed to the sun, an effect resembling the much desired north-light.

Windows wholly glazed with translucent sheets are not, however, entirely satisfactory. Workmen usually like to be located near windows. Some bosses object to such an arrangement on the ground that much time is lost in looking out, especially by women workers. The well-informed foreman knows that the desire to look out of the window is not only legitimate on the part of the workman, but is a positive help to efficiency. The operator's eyes, if constantly fixed upon nothing but the work before him, or upon the nearby objects in the shop, grow wearied and strained. A momentary glance at something distant relieves the strain, relaxes the tension, and permits the eye to work on refreshed, as it were. This is the basis, though not always consciously, for much that employers have done recently in making the external environment of their factories as well as the internal, more presentable to the eye. The advantage of an open site, as compared with a crowded city location, is apparent in this connection.

The various forms of prismatic, maze, and other translucent glass, prevent this relief to the eyes of workmen; and it is, therefore, advisable, in order to satisfy all the conditions,

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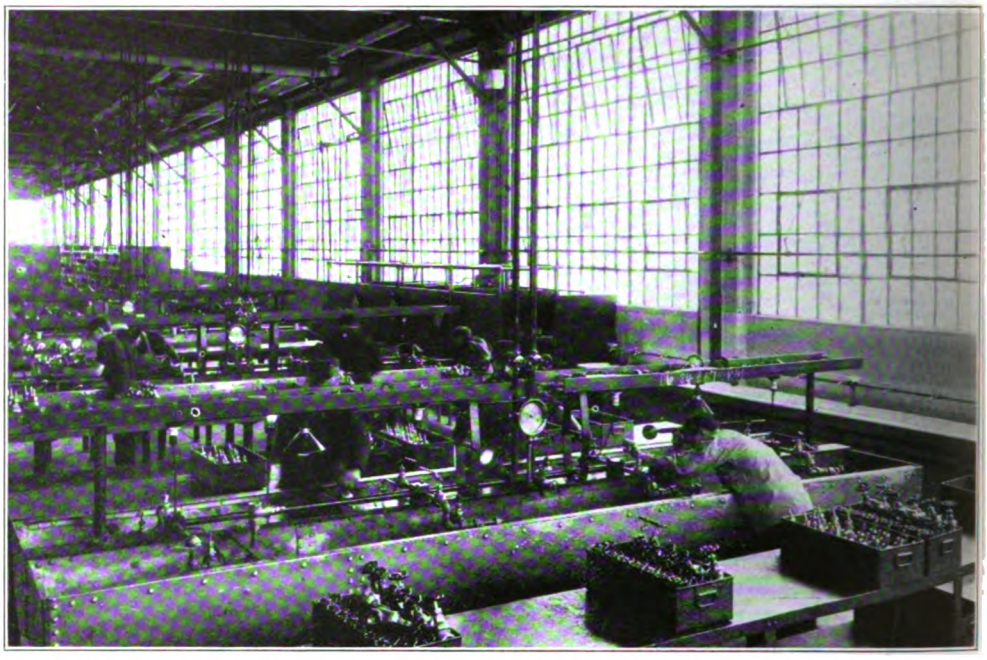

PROPER ARRANGEMENT OF WORK TABLES AND MACHINES

In the plant of the Nelson Valve Company, Philadelphia, Fenestra sash and mechanically operated ventilating sash give sufficient light and ventilation. By the arrangement of the work benches the workmen do not face the light or work in their own shadows

to use these, or some one of them, in connection with plain glass. Experience indicates that most satisfactory results are obtained in narrow rooms, say up to twenty or twenty-five feet in width, by glazing the upper sash with maze glass, and the lower with the plain, windows being placed on one side of the room only. In rooms wider than this, and not exceeding about forty feet, windows should be placed on both sides of the room and glazed as already indicated. Wider rooms, to sixty feet, require factory-ribbed glazing in the upper sash, and windows in both side walls; and for rooms wider than this it is necessary to use sheet prismatic glass, the lower sash in all cases being glazed plain. Where ribbed or prism glass is so used, the ribs are to be parallel to the floor, as already pointed out.

It should be remembered in this connection that while diffusing glass is necessary to accomplish the results here indicated, a superfluous use of it means unnecessary maintenance expense as well as greater prime cost. For it is obvious that plain glass is kept clean with considerably less labor and trouble. The keeping clean is of quite as much importance as the sufficiency of the lighting area. For what profiteth it if one has a world of lighting area, but keeps the light out by accumulations of dirt and smoke?

In this connection it should be pointed out also that provisions must not be overlooked for facilitating the cleaning, and making it safe for the cleaner. Hooks or bolts for the scaffold, platform, or harness are to be provided, whatever the form of sash or casing.

Another very important matter is usually wholly overlooked, even when ample lighting satisfactory in quality

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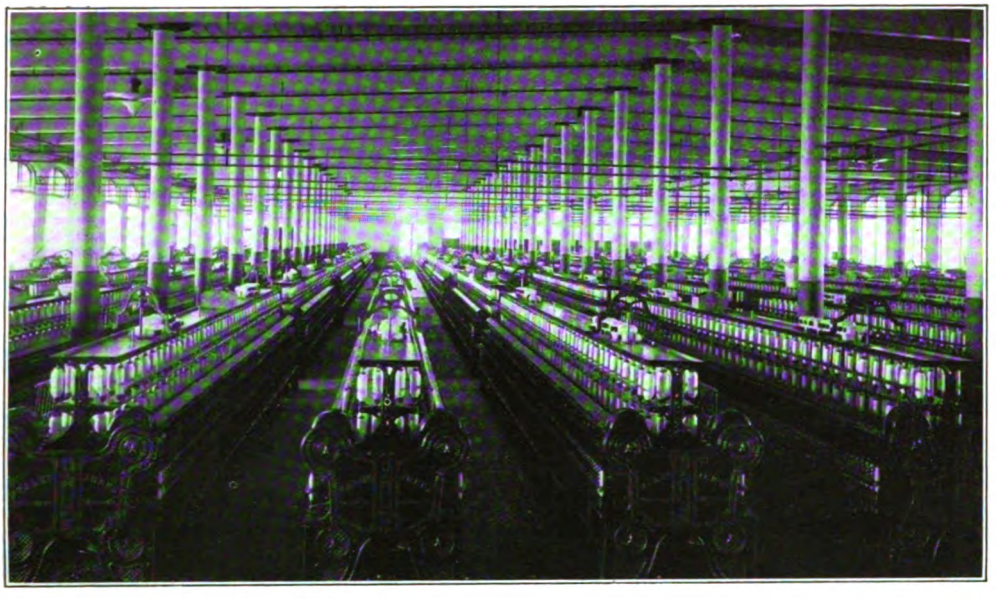

IMPROPER ARRANGEMENT OF MACHINES

While the lighting is good, yet much more effective lighting on the machines would have been secured had they been placed parallel to the end of the room instead of parallel to the sides. The machines being motor driven, the other arrangement could easily have been secured

is provided—that is, the disposition of machines and work benches with reference to the source and direction of the light.

Intelligent horse owners have long known the ill effects of keeping their animals in stalls with window openings directly in front, and have avoided such an arrangement. In work shops, however, it is the usual thing to see rows of work people ranged before benches or at machines facing the windows. A comment might be offered here, which is possibly sufficiently obvious.

Anyone who has ever had to face a source of light for any considerable time, even when well diffused, must realize how fatiguing it is. Innumerable headaches and eye aches, and the ills that follow in their train, may be traced to this cause. Besides this, there is also the other factor involved —the waste arising by reason of insufficiently accurate work resulting from eye strain and fatigue.

It is very important, therefore, that machines, tables, benches, and the like be so disposed that direct light does not fall into the face of the workers. A position at right angles to the source is perhaps not quite so good as one at a slightly less angle. The latter permits side glances out of the windows to relieve the eyes, with less effort and perhaps without taking attention from the work in hand more than momentarily.

Even where the site has been selected with due consideration to this part of the problem, as the plant develops special cases are likely to arise in respect to lighting; and, as more often than not is the case when a plant is located chiefly on other considerations, some of these special conditions are pretty sure to prove troublesome. In a congested district, for example, there are almost certain to be high walls shutting out much of the natural light. Not infrequently it is impossible to

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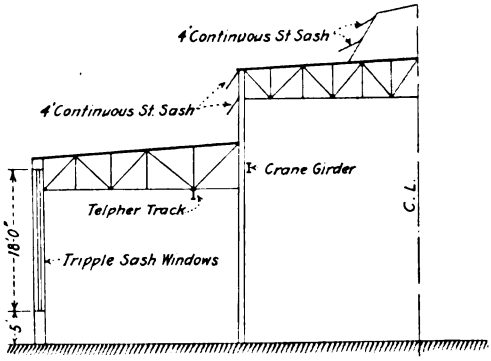
get adequate illumination directly. Particular conditions in an ideal location even may also bring about a similar situation. In such cases much can be done by the use of canopies of prism glass so set as to refract into the windows such sky light as may be available. The window glazing may, if necessary, diffuse the illumination in the usual manner. It may under particularly trying circumstances be necessary, in order to secure the desirable illumination or distribution of light, to utilize prism canopies or refractors inside a room, possibly in combination with others outside or in the window openings. It is surprising what good results can be obtained in this way.



HALF-SECTION OF MALLEABLE FOUNDRY, AUBURN PLANT, INTERNATIONAL HARVESTER COMPANY

A modified "lantern" type of building with ventilating sash in clear story and sash in lantern set at an angle like that of a saw-tooth roof. Excellent lighting and ventilation. Designed by Wm. J. Lees

The best thing of course in such a situation is to light from the roof; but this again is not feasible if more than a single story is required, except for the upper story; though indeed light shafts are sometimes made use of for this purpose. Without the use of prism glass canopies, however, these latter have small value; and in any case they require valuable space, besides being very objectionable in that they are a constant menace in case of fire.

If roof lighting is feasible, however, it is much better than side lighting of any kind, and in any event should supplement the latter as far as possible. In very large buildings, such as foundries, erecting shops for large machinery, and the like, this is imperative to secure sufficient illumination for the central bays. The conventional type of light for this purpose, in such buildings, has for many years been the "lantern" or (improperly so-called) monitor, with windows set parallel with the side walls of the building. Such an arrangement may have some advantage in respect to ease of ventilation; but certainly lacks effectiveness in respect to lighting, even with the best possible glazing.

A late modification of this type of lighting, intended to secure a maximum ventilation, along with maximum lighting effect, especially applicable to forge shops, foundries, and other places where smoke, fumes, steam, or gases are concomitant of the work and are not readily disposed of during the larger part of the year, combines pivoted side lights with a lantern having its glass sides set at an angle and much farther apart than usual. An example of this type is illustrated herewith. The side lights of the side bays are supplemented by additional pivoted sash in the upper part of the clear story. The shop is 120 feet wide at the ground, while the lantern is 21 feet wide at its base and has its sash set at an angle of 22½ degrees from the vertical—all sash glazed with ribbed glass.

The place, when all open, is like out of doors, in respect to light as well as to air. In operation there is an entire absence of the customary smoke hanging over the molding floors. The workmen are delighted

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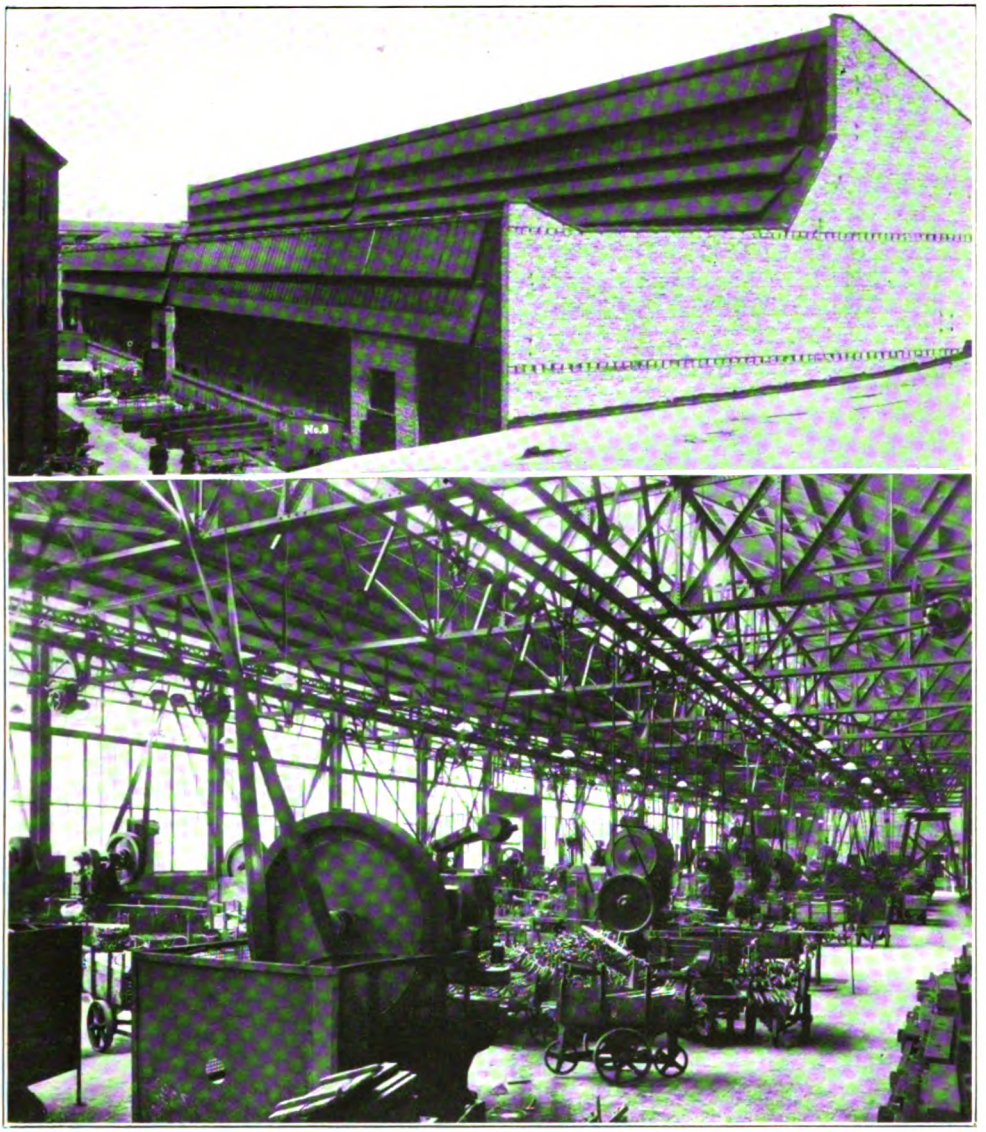

EXTERIOR AND INTERIOR VIEWS OF PLANO WORKS, INTERNATIONAL HARVESTER COMPANY, WEST PULLMAN, ILLINOIS

Showing Pond truss with Pond continuous sash controlled by Pond operating device in monitor and upper side walls, Lupton steel sash of the counter-balance type in the side walls. Manufactured by David Lupton's Sons Company, Philadelphia

with the conditions, and insist that they can pour twice as many ladles as they had been accustomed to doing, and still be less tired than before they worked in the new foundry.

Recently the flush skylight, let into the roof and pitching approximately with it, has come into favor. This undoubtedly does fill the requirements as to central lighting insofar as amount or intensity is concerned. The trouble is, indeed, that the light is likely to be too intense when plain glass is used, as is often

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EXCELLENT RESULTS OF SIDE LIGHTING COMBINED WITH FLUSH ROOF SKYLIGHTS
Interior of the Induction Motor Department, Schenectady Works, General Electric Company

done. More serious still, whatever the glazing, is the trapping of heat rays, which on warm days makes the floor below uncomfortable to the workmen, and not infrequently intolerable. Covering the under side of the glass with whitewash or other coating of a similar nature, reduces the trouble. A new one is introduced, however, in the flaking of the coating, or its darkening by dust or smoke. The fabric composition sometimes used for skylight work instead of glass, keeps out a little of the heat, and gives an agreeable mellow light. Its durability and fire resisting qualities are not comparable with those of wire glass however; and the relative opacity of the material makes it necessary to provide a larger lighting area than would be necessary with glass, to secure the desired illumination.

Besides the difficulty just mentioned, there are two others having to do with the construction of skylights, which. have heretofore been troublesome, namely, leakage and condensation. At the present time there are a number of water-tight settings available which practically eliminate leakage, and which also take care of the condensation drip. Also there is a glass tile on the market, suitable for use in connection with ordinary tile roofs, which is as satisfactory in respect to lighting as is any other form of skylight, and which at the same time requires no different setting from that needed for terra cotta tile.

Undoubtedly the best lighting obtainable for workrooms is that from a properly designed and constructed saw-tooth roof, a type imported from Europe and greatly improved here. The windows facing the northern sky at an angle varying with the

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GLASS TILE IN THE FACTORY OF THE FEDERAL CEMENT TILE COMPANY, CHICAGO

An example of overhead and side lighting using Federal glass tile throughout. This main building is 100 feet by 400 feet

latitude admit no direct sunlight, but distribute practically all the light admitted evenly over the floor within their range. In the latitude of New York or Chicago the angle should be in the neighborhood of sixty degrees from the horizontal. The requirement is to get as great an exposure to the sky as is possible without permitting the entrance of any appreciable amount of direct sunlight. The use of vertical sash, or lights nearly vertical, occasionally found in connection with this type of lighting, practically defeats the purpose and is therefore absurd.

The excellence of saw-tooth roof-lighting was demonstrated in textile mills, where the conditions are especially exacting long before this type of roof was applied generally to machine shops and other types of manufacturing plants. It is, of course, peculiarly adapted to the low one-story building, but is at times used for the upper story of multi-story buildings. Until recently its use was confined to buildings of the former type, and it has been regarded as impracticable upon high and wide buildings of the heavy machine-erecting and foundry type. It has been shown, however, that the sawtooth method of lighting is just as applicable to buildings of this type as to others, and that the combination of this form of roof lighting and side lighting as usually practiced in shops of this character, obviates the troubles and difficulties already pointed out as characteristic of ordinary skylights.

This new type of roof lighting, possessing all the advantage of all the others, is not difficult of application. Instead of the customary high-pitched roof with its comparatively expensive roofing material, a flat

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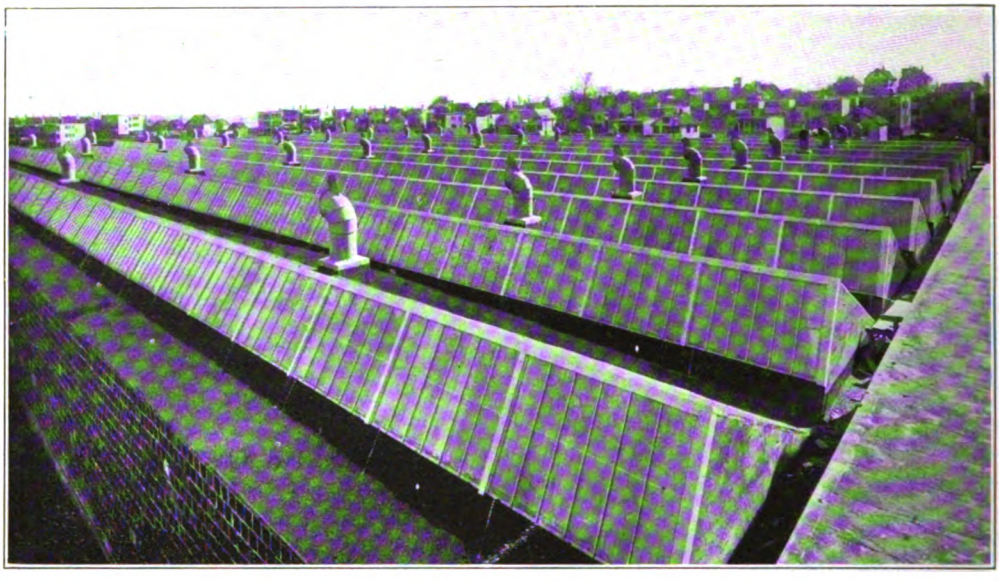
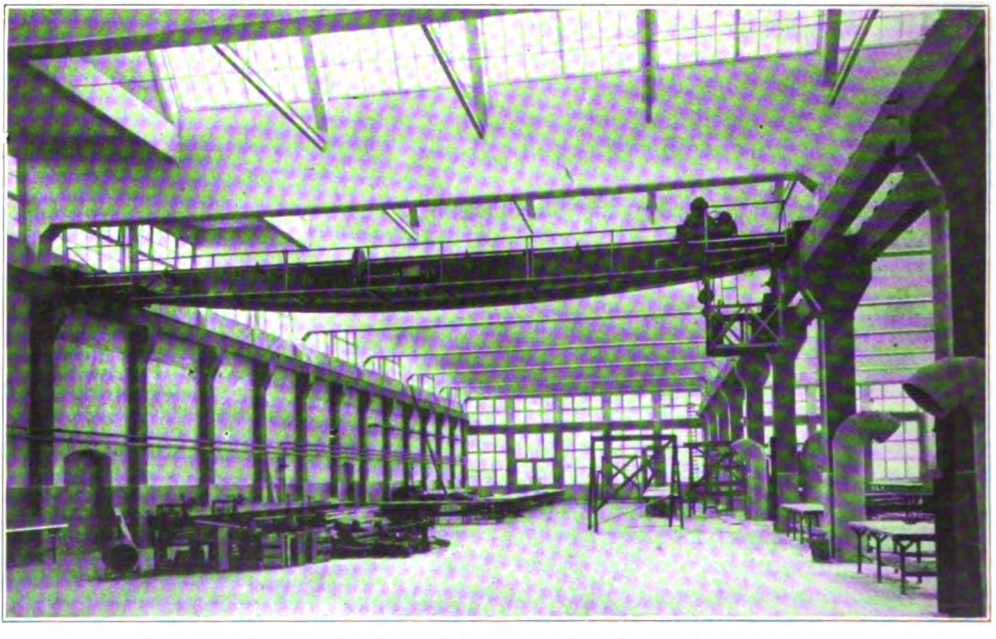


SAW-TOOTH ROOF PROVIDED WITH VENTILATORS

View of the roof of the Maverick Mills Corporation, East Boston. Lockwood Greene & Company, Architects and Engineers

roof can be used, permitting the use of the cheap tar and gravel roofing; and upon this and over the central bay the saw-teeth are set at the desired intervals. The side bays and galleries are lighted by side windows.



INTERIOR ASSEMBLY BUILDING, PIERCE AUTOMOBILE PLANT, BUFFALO

A very excellent form of saw-tooth roof lighting in a reinforced concrete building. The Kahn system of reinforced concrete is used throughout. Trussed Concrete Steel Company, Detroit, Michigan

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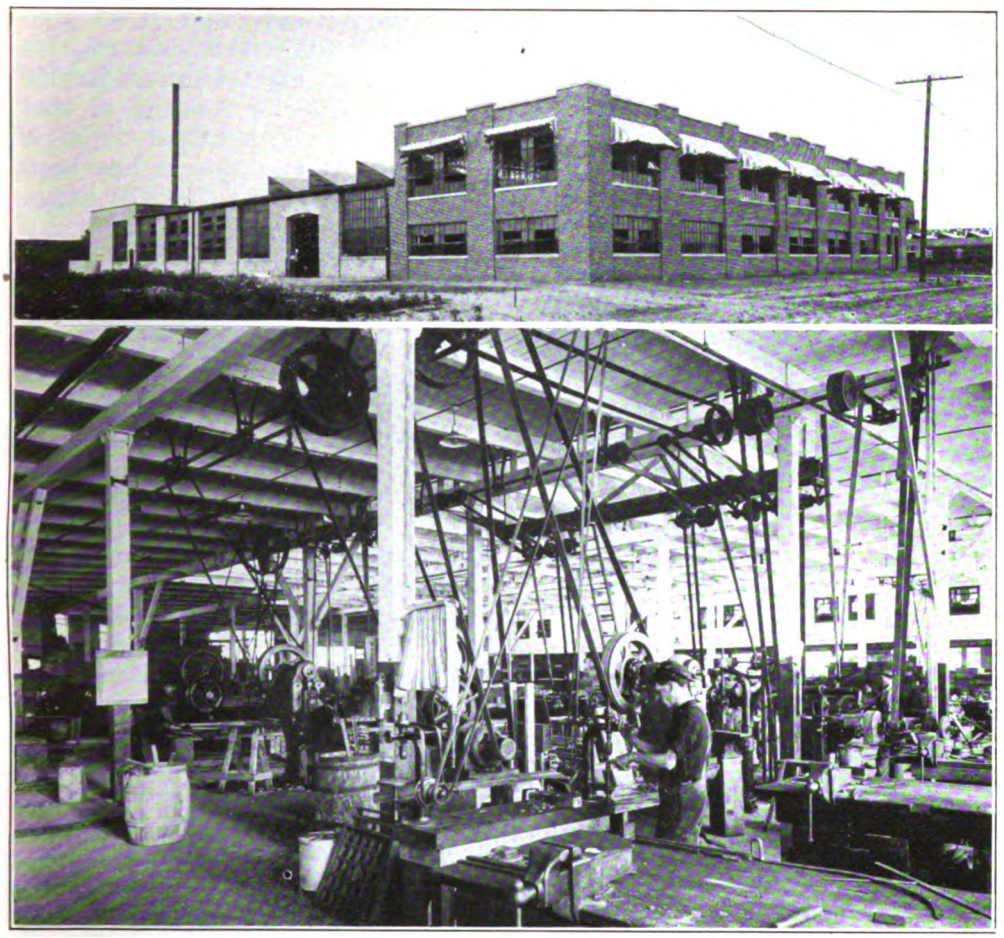

FACTORY OF THE AMERICAN 3-WAY PRISM COMPANY, LA PORTE, INDIANA

Saw-tooth lighting is used to supplement the side windows in this very wide shop—180 feet in width

The drainage of the valleys in saw-tooth roofs presents no serious difficulties, if care is taken to give depth and pitch enough to carry away the water. If the valleys are necessarily very long, the gutters may conveniently open into spouts carried down through the shop, next to or even within the supporting posts, or, in the absence of these, following the trusses or girders. Where the saw-teeth are over the central bay only, as in wide machine shops, the gutters between the saw-teeth can be made continuous with the main roof over the side bays, and no interior down spouts are then necessary.

In order to get the full advantage of good lighting, it is desirable that the interiors of buildings be painted white or, better, a greenish gray. This serves the double purpose of aiding the dispersion of light, and of indicating the relative slovenliness or cleanliness of the place. Whitewash is often used for the purpose, because it is cheaper than paint; but its lack of durability and its flaking off constitute a continuous nuisance.

Machines and other permanent fixtures should likewise be painted in the same manner instead of the cus-

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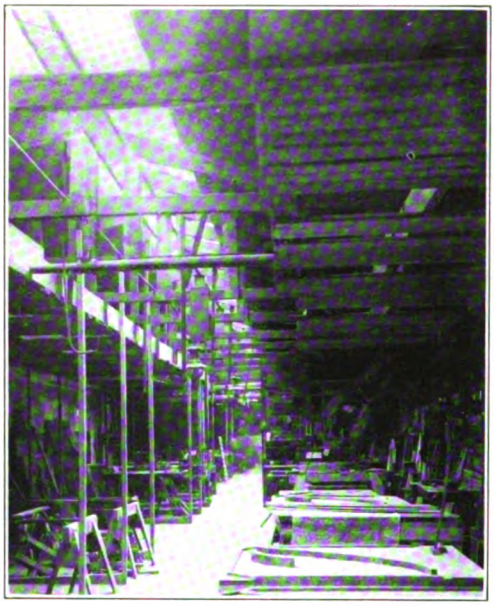


A BADLY LIGHTED SHOP

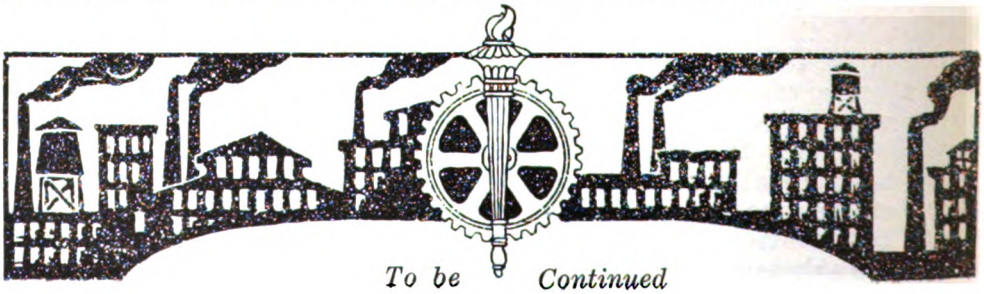
The light comes from a roof window which lights an alley down the center of the room, but which leaves the major portion of the room in semi-darkness

tomary black. All dark surfaces absorb light, and therefore reduce the effectiveness of the illumination, whether the source be sunlight or lamplight. The necessity for keeping the interiors of workrooms and their contents at least fairly light colored by removal of grime and by repainting should be obvious.

Natural light is by all means the best known illuminant. The very best artificial light gives but a small fraction of the illumination given by sunlight, whether direct or indirect. The influence of poor light upon the efficiency of workmen has already been pointed out; and it is now proven that the well known relative inefficiency of night work is largely due to the inferior lighting at that time when only artificial light is available. At any rate it has been shown by actual test that the after-daylight output of a given shop can be very considerably increased by efficient lighting—as much as twenty percent in one instance where the subject was carefully investigated.

At the very best, artificial light costs money. One of the absurdities of former factory design, not yet altogether outgrown, is the skimping of windows and the consequent necessity for investing considerable additional sums in power plant (and the further continuous expense of operation ever afterwards) to make good, in small part, the deficiency. Saying nothing of the investment in power plant, it has been shown conclusively that the cost of furnishing light for a workroom needing artificial illumination any considerable part of the day is enough in a comparatively short time to cover the cost of adequate provision for natural lighting. It is indeed absurd to pay for an inferior quality of what can be had in unlimited quantities for nothing.

Adequate provision for artificial lighting, nevertheless, is essential. The long work day during the winter season when daylight lasts but part of the time, possible exigencies requiring night work, and dark days, all need to be provided against.



To be Continued

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INDUSTRIAL LESSONS FROM THE GERMAN WAR MACHINE

By C. E. Knoeppel.

II. PRINCIPLES OF GERMAN MILITARY EFFICIENCY

Last month Mr. Knoeppel showed the reader the astounding efficiency that has marked Germany's conduct of the War, especially in her actual military operations. In this installment, he analyzes the causes of this efficiency and correlates them with the familiar principles underlying our new American philosophy of industrial management. In his next chapter, Mr. Knoeppel will take up the topic of Germany's Industrial Methods, and will follow that with a final chapter showing How We May Adapt the Principles of German Efficiency to Our Industrial Needs.—THE EDITORS.

MADAME LAFONTAINE, wife of the Belgian senator, who won the Nobel peace prize last year, took me to task, after an address before the Lake Placid meeting of the Efficiency Society, because I advocated our using industrially, the principles behind the German warfare. My rejoinder was that I was not advocating the German method of applying these principles, but that I felt we could apply them differently, to worthy ends, without in the slightest destroying their efficacy as principles. This same argument I used more recently when criticised by a close friend over what he termed "my ambition to Germanize American industry." The principle is one thing—the manner of applying distinctly another.

Here is my point—to avoid being misunderstood: As a machine the German war machine, as well as the German industrial machine, is remarkably efficient. In the building of these machines all the principles of true efficiency were considered, as will be shown later. I am not urging that we build our military and industrial machine after the German plans and specifications, back of which are the rightly condemned Prussian militarism and the almost entire subordination of the individual to the state. I do urge, however, that we take the German model, determine the governing elements and principles of design and so rearrange and readjust, as to give us a machine, which while patterned after the German unit, will conform to our different ideals and civilization. Theodore Roosevelt, although he has bitterly criticised much that the Germans have done, recently said:

> "Germany has out-distanced us in her industrial efficiency and now it is for us to show that a democratic government which guarantees personal liberty is not inconsistent with such industrial efficiency."

The question, therefore, for all of us to consider is whether or not we are going to consider or ignore the lessons which the Germans can teach us, which if studied and applied will make us the most efficient industrial nation on earth.

That the Germans believed warfare could be made scientific is indicated by Von Bernhardi in his book, How Germany Makes War, as follows:

> "One might almost come to think that success in war will be more or less a matter of chance, which can in no way be influenced by foresight.
>
> "I think it is not so, after all. If we closely examine the possible effect of all the new phenomena which in a future war must assert themselves, and then test them in their relation to the general laws of

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warfare, we must succeed in getting a general idea of the nature of modern war, and in ascertaining a method by which we can act most suitably.

"This is the way he has shown us (Moltke). We are not to rest satisfied with what he has thought and done, but to go on unfettered, turning to account fresh developments. We must examine the conditions under which a future war must be conducted without blindly believing in authorities and from what Moltke and the German wars of unification taught us, to develop new ideas and principles according to modern requirements."

Let us, therefore, determine, if we can, what these principles are which have enabled two nations successfully to hold off seven nations on three fronts while keeping all fighting in the enemies' country, and how they can be applied to industry. Close study reveals six principles which enter into the conduct of war and which the Germans have put into efficient practice. These will be considered, not in logical order, proceeding from one to six, but the reverse, as this will more clearly bring out the essentials I have in mind.

Nations engage in or prepare for war because they believe something will be gained by doing so. It may be for protection and freedom from the aggression of a hostile neighbor. It may be for purposes of defense or to right a real or fancied wrong. It may be for territorial conquest or commercial supremacy. Regardless of the point of view, war does have its rewards, as everyone familiar with our Civil War and the Revolutionary War well know. There must certainly be some incentive warranting a nation plunging into a thing as terrible as a modern war. If not, why go to war? We can, therefore, consider the sixth principle as one of *Rewards.*

The German thought with reference to this principle can be best appreciated by quoting from Von Bernhardi:

"Germany supports 65,000,000 inhabitants on an area about equal to the size of France, while only 40,000,000 live in France. Germany's enormous population increases annually by about 1,000,000. There is no question, agriculture and industry of the home country cannot give permanently sufficient employment to such a steadily increasing mass of human beings. We, therefore, need to enlarge our Colonial possessions so as to afford a home and work to our surplus population, unless we wish to run the risk of seeing again the strength and productive power of our rivals increased by German emigration as in former days. With every move of our foreign policy to-day we have to face a European war against superior numbers. This sort of thing is becoming intolerable. Such a state of affairs is highly dangerous, not only for the peace of Europe, which, after all, is only a secondary matter for us, but above all, is most dangerous to ourselves."

Whether the rewards the Germans had in mind, as expressed by Von Bernhardi, were lofty ones, or whether they were unworthy a civilized people, is not a question for discussion here. *Rewards,* as a definite and important principle, is the main consideration with which we are concerned.

The question now is: How did the Germans go about the work of winning these rewards? They knew that to win the rewards of a war, men would have to know how to fight to best advantage—how best to endure the hardships of war. The cavalry, infantry, and artillery forces would have to know what to do at all times. Rapid mobilization would be an important factor, as well as long and fast marches. Borrowing a modern term we have as their fifth essential, *Standardization,* or the proper way of actually doing things.

That this principle received an unusual amount of consideration is evidenced by the writings of such military men as Von Bernhardi and Von Clauswitz—the one a recent writer, the other an earlier one (1830). Note the surprising parallel between war and business in the reading of the fol-

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lowing extract from Von Clauswitz:

"As contemplation of war continually increased and its history every day assumed more of a critical character, the urgent want appeared of the support of fixed maxims and rules, in order that in the controversies naturally arising about military events, the war of opinions might be brought to some one point.

"Commanders and troops must be past masters in the art of operations, if simple movements are really to run smoothly. Simplicity of action which confers superiority over the adversary is derived from complete familiarity with the means of warfare alone."

The reasoning of the Germans with reference to the fourth essential is entirely logical. To win the rewards they had in mind would need perfect operations, which in turn meant that master minds would have to pull the strings and co-ordinate the thousand and one details; would have to know at all times what to do and when. Orders to troops, movement of armies and equipment, arrangements for feeding the men, supplying ammunition, taking care of the killed and wounded, handling provisions, would all have to be a matter of clock-like precision, the principle being that the men at the front were there to fight, and not to cook meals, bury the dead, or wait for equipment and ammunition. This sounds familiar and is nothing but *Planning*.

Again, Von Bernhardi:

"But the task is to solve the riddle *in advance*. That kind of mental labor must bear rich fruit. It will best prepare victory. It must be done."

In order to plan, standardize, and win the rewards of war, what else was needed? Information of all kinds. The Germans, for instance, scientifically select those who are sent into the field. A manufacturer or banker, of the right age, would be left at home if he could do constructive work for the Empire, while those who could be spared would be sent to the front. This required a careful indexing of every available fighting man with reference to occupation and possible service to the country in case of war. The manufacture of field equipment, guns, ammunition, clothing and the like were all based on the best and most reliable kind of information. The remarkable spy system of the Germans furnished much of its pertinent data. This all means *Records*, which constitutes our third principle.

The Germans wisely saw that to know what records to collect and then collect them; to plan properly with as little error as possible; to conduct efficient operations and to win the rewards they had in mind, would require a personnel of such power as would enable them properly to consider what they decided upon as essential factors. They built what is commonly known as the "German War Machine" a marvelous organization of the best brains they could find, which could take warfare and make a science out of it, as well as carry out the principles determined upon. *Organization* was, therefore, their second essential. On this, says Von Clauswitz:

"The contest of war is not a contest of individual against individual, but an organized whole, consisting of manifold parts."

What governed the building of this organization? What records would have to be compiled? What would be planned? How would standardization be carried out and why? What would insure the rewards? Consider yourself the German war machine confronted with the task of applying the principles mentioned and you would immediately ask questions as follows: What nation would we have to fight? With powerful nations all around us, how many nations would we have to fight at any one time? (It seems the Germans considered fighting the whole world and planned accordingly, which at least shows that they left little unconsidered.) What is the nature of the countries we might be forced to war against?

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What are the financial and fighting resources of these countries? Where would the greatest strength of the enemy lie, in its army or its navy? What are the various nations bringing out in the way of war implements? What is the condition of the enemy as to fortifications? What are our resources in men, equipment, facilities, and finances? Through what kind of countries would our armies be forced to march?

Thousands of questions along the same lines you would consider as governing the things you would do, which means *Investigation.*

Says Von Clauswitz:

"Investigation and observation, philosophy and experiences, must neither despise nor exclude one another."

And Von Bernhardi:

"Opposed to these efforts are the most powerful states in Europe. France wants to take revenge for 1870-71 and regain the old political hegomony. Russia has a lively interest in not allowing our strength to increase any further, so that she may pursue her political plans in the Near and Far East undisturbed by Germany. Russia may also, perhaps, dream of a future supremacy in the Baltic. If at the present moment—weakened by recent events in the Far East—she seems to pursue pacfiic tendencies, she is sure to return to her policy of aggression sooner or later, and finally, England is particularly hostile toward us, in addition to France."

Here is the list in logical order which the Germans considered in making war a science.

First, *Investigation*: Finding out what to do.

Second, *Organization*: Building the machine that would properly carry out what should be done.

Third, *Records*: Gathering facts and statistics to be used by this organization in arriving at the right kind of conclusions, in carrying out what should be done.

Fourth, *Planning*: Logically arranging and co-ordinating all details so that the various steps can be rapidly and efficiently carried out.

Fifth, *Standardization*: Carrying out the steps determined or actually doing the work in a proper manner.

Sixth, *Incentives*: The results of the successful application of the other five.

In other words, the Germans realized that to win the rewards of war, the actual work would have to be done properly by well trained men, after the most careful kind of planning, based on and as indicated by records secured through an efficient organization, which thoroughly investigated every possible feature in connection with the task ahead of it.

How does Germany apply these principles? Through a general war staff, which is the thinking brain of the German army and is divided into two parts, the staff with the troops having Von Falkenhayn in charge, and the staff at Berlin with Von Moltke in charge. Under the German plan, politicians and administrators are excluded from the sphere of military operations, for upon mobilization the government takes second place, the General Staff controlling and carrying out the war. The Chief of Staff is in no way responsible to the Chancellor but only to the Emperor and to him alone. From this it can be seen that politics cannot enter into the conduct of the war. The staff, made up of the best brains in the army, is in the best possible position to carry on the war most efficiently and without the interference of laymen full of theories. Contrast the handling of the war by the British Cabinet, with the way Germany has worked through her General Staff.

Are they sound, these principles which we have outlined?

Clement Kinlock-Cooke in the *Nineteenth Century and After*, said:

"Organization in any undertaking, in any contest, in any campaign, is an essential precedent to success. To disregard it is to

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court failure, to invite disaster. That being so, it follows logically and conclusively that if we are to win the war in a reasonable time, and without undue and unnecessary expenditure of life and money, the entire community must be organized."

Sydney Brooks in *The Atlantic Monthly* made the following statement:

"Great Britain can find room for and in almost all departments of life stands to benefit by, those qualities of patient foresight, scientific exactitude, thoroughness in preparation, thrift, realism, and devotion to the State of which Germany has set so far-shining an example. For these are virtues that already exist in the British character but are largely lost to the national service through faulty organization."

Yes, but, you say, Germany was preparing for this war since the conclusion of the France-Prussian war. Not according to J. Ellis Barker, who said in an article, "The Secret of Germany's Strength" in the *Nineteenth Century and After*.

"Not forty years but for two hundred sixty years, since Frederick William, the Great Elector, came to the Prussian throne, the slow-growing plants of German efficiency and thoroughness have steadily unfolded, in the administrative, military, financial, and economic policy that make modern Germany."

But what has all this got to do with ousiness—with industry? Bernhardi says:

"To strive always for the highest possible success, with the utmost energy, is the first principle of all warfare."

Couldn't this be hung up in the office of every executive by substituting tne word "business" for "warfare"?

Von Hindenburg himself frankly admits that the strategy and tactics which have made him by far the greatest single figure in this world war, did not originate in his brain. To a great extent his maxims of war are those of Frederick the Great, who in turn adapted them from those of the great Chinese warrior Loutao, who as early as 1150 B. C. said:

"The strength of an army depends less on numbers than upon efficiency."

Can't we change this to read:

"The strength of an industrial plant depends less upon numbers or money spent than upon efficiency?"

The great question now confronting us is: What is behind military efficiency in general and the German military efficiency in particular? To indicate what the lack of efficiency leads to, let us use Great Britain as an example, and to avoid being unduly criticised for taking the British to task, let me submit the following from an editorial in the *Daily Mail*, on a speech by David Lloyd George on munitions and the labor situation:

"This speech contains the gravest indictment yet drawn against the Government. 'Too late' is written in letters of fire upon the Government record. Too late in aiding Belgium; too late to save Serbia; too late in the Dardanelles; too late with munitions —these words have dogged the allies every step."

This to show what industrial efficiency is not, painted not with a desire to criticise England, for she is nobly fighting against enormous odds also, with her bull-dog tenacity, but to show more clearly the definite and inseparable relation between military and industrial efficiency. I know I am treading on dangerous ground; in fact, my close friends have told me that I will incur the ill will of all pro-allies by my frank discussion of the German war machine. If, however, I can by laying particular emphasis on the bad spots, open the eyes of some to the need of industrial preparedness, I am willing and can well afford to stand any amount of personal criticism.

Let us, therefore, change the wording of the six principles as applied to war, so that they will apply to industry.

1. *Investigation* — Determining what is wrong.

2. *Organization* — Building the machine which will correct the faults.

3. *Records*—Facts and statistics showing what is being accomplished

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and what remains to be done and where.

4. *Planning*—Co-ordinating productive efforts.

5. *Standardization*—Determining the right methods to follow in the actual performance of work.

6. *Incentives*—Rewarding those who perform efficiently.

The art of using these six principle we will term Reorganization, which means the bringing of things to an organized condition.

Does American industry need reorganization? Yes, if we are to be the most efficient industrial nation on earth and if we study the industrial efficiency of Germany. By all means, if our efforts toward "preparedness" in a military and a naval sense are going to amount to anything. Major O'Keefe before the Pilgrim Publicity Association of Boston, said:

"I can think of no more profitable pursuit for the trade organization throughout the country and for merchants and manufacturers generally, than will be found in the study of Germany's methods of promoting commercial and industrial efficiency and expansion."

What are the German industrial methods? When entire books are given to a description of their methods, all we can do here is to outline them in the most general way. The doctrine behind industry in Germany was proclaimed by Bismarck and means nothing but *Rewards* to both worker and state:

"Give the workingman work as long as he is healthy, assure him care when he is sick, insure him maintenance when he is old. Was not the right to work openly proclaimed at the time of the publication of the common law? Is it not established in all our social arrangements, that the man who comes before his fellow citizens and says, 'I am healthy, I desire to work, but can find no work' is entitled to say also, 'Give me work,' and that the state is bound to give him work."

"'But large public works would be necessary,' exclaimed an opponent. 'Of course,' replied Bismarck, 'let them be undertaken. Why not? It is the state's duty.'"

Speaking of the German workman, Prof. Brown of Cornell says:

"He must be defended against the risks of his calling and be made a contented workingman, able to educate his children, as workingmen, perhaps, but in comfort and decency.

"That is the inner meaning of the German social legislation, of that insurance which has insured fifty million people against sickness, twenty-five million against accidents, sixteen million against old age."

In other words, the state takes care of the individual and, of course, the indivdual is willing to help the state when his services are needed.

Another secret of German industrial success lies in the state's fostering of right relations between worker and employer. W. H. Dooley in the *Atlantic Monthly* (May, 1911) said:

"The German Government recognizes the duty and exercises the right of regulating industries in the interest of the employed; but in doing so, it is careful to keep in view the general industrial interests."

Regarding German industry and the banks, Thomas A. Edison in a copyrighted interview in the *New York Times*, says:

"One great advantage which the manufacturers of Germany have over us and over every other country is to be found in her great promoting banks. In the United States the man who wishes to get something new on the market must get hold, in one way or another, of a promoter of his enterprise, and our promoters are notoriously irresponsible. Their inventions are brought out by the promoting banks. The same plan can be followed by the manufacturer who wishes to extend his business."

W. H. Dooley also said in the article just referred to:

"The average American thinks that the success of Germany is due to low wages and long hours of work. This is not true, for if labor is cheaper there, coal is dear, machinery dearer, and imported raw material pays a tax. The industrial supremacy of Germany is the effect of a definite and deliberate political action. Thrift was multiplied by capital and education multiplied by industrial efficiency."

As Dr. Robert Fletcher, of Dartmouth College, well says:

"It is not her army of soldiers which

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other nations need to fear, but her armies of scientifically trained directors of industrial enterprises and of highly educated commercial agents."

Professor Potter of Harvard University in a lecture before the Forsythe Dental Infirmary, said:

"The teeth of the English soldiers in the trenches are in poorer condition than the men of any other power. The French rank much higher as regards mouth hygiene efficiency, with the Germans heading the list, almost 100 per cent. perfect.

"The German soldier, perhaps, through the foresighted and long preparing German nation, is faring the best of any, especially as regards his teeth. For more than fifteen years Germany has been caring for the teeth of its subjects, establishing clinics in the public schoos, dental infirmaries in the smaller towns and villages as well as in the cities, and, on the whole, making sure that no child, especially a boy, is allowed to let his teeth get into that state of decay which would necessarily cause his rejection at the time of a call to his colors."

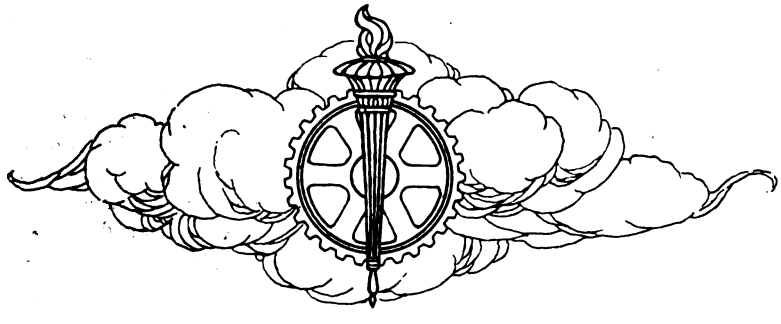
I am sure that if proper study is given to the outline of the six principles mentioned, there will be less "hit-and-miss" in American industry. After a long experience in industrial activities, I am convinced that there is more of it than most people have any idea of. As a writer recently said:

"What is meant by 'hit-and-miss' in industry? We who live in this country should know. We are passionately devoted to it. We suffer from it, but we would apparently die for it. Many die from it. It is the system that permits the business of the production of the necessities of life to gravitate into the hands of individuals, each of whom is permitted to go his own pleasant way. Not even our Government may tell any individual what he shall produce or how much he shall produce. We have a theory that the 'law of supply and demand' regulates all such matters much better than we could regulate them. England has the same idea. England would be all right today if the idea prevailed in Germany. The British steel wall would have long since done its work. But Germany has a different idea. She had it even before the war. She believed in orderly industry."

I am not prepared to say how far we can go in this country along the same lines, but I do know that there can be no order in industry until we get away from the "each for himself" attitude and adopt a slogan something like that of the Germans, "One for all and all for one."

We are free people; we have wonderful resources in money, men, and materials; we believe "in union there is strength"; we are an unusually prosperous nation; we are now contemplating "preparedness." Will our people, believing as they do in unity, take these resources and through the proper application of the six principles named, *prepare industrially* as well as in a military sense to lead the world, or will it take a great war to shake us free from individualism and force us, as it is forcing England, to learn the great lesson that the power behind the most efficient civilization is organization?

To be continued



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Co-Relationship of Factors Affecting the Cost of Power

By Reginald Trautschold

While the cost of power may not be a comparatively large item in the total cost of manufacture, yet it is an important one, and the industrial manager and the power-plant operator is constantly seeking to decrease that cost. The factors affecting it are so variable that an accurate predetermination of costs is almost impossible. The accompanying charts, presented by Mr. Trautschold consider these variables, and from them a fair working knowledge of total costs may be gained.—The Editors.

So many factors affect and so many conditions govern the cost of power in a coal burning steam plant that any reliable analysis of the costs entering into this very important consideration would appear to be a herculean task, and an attempt to arrive at an accurate allowable proportion of the total cost to allot to each factor affecting the whole, an impossibility. Nevertheless, just such a problem confronts the management of every power house striving for efficiency and economy in operation, and the results attained by the most efficiently operated plants fixes the standard for all. The most efficiently operated plants, those in which power is generated for the least expenditure commensurate with the existing conditions, are the profitable ones.

It is not difficult to ascertain and classify the factors bearing upon the cost of power. They can be listed in four groups: First, the "fixed charges," which consist of interest, taxes, insurance, depreciation, and repairs on the land upon which the engine and boiler rooms stand, the buildings, chimneys, equipment, accessories, foundations, piping, installation of machinery, etc., and the burden imposed by freight and cartage; second, the "cost of attendance," which covers all labor expenses, clerical assistance, etc.; third, the "cost of supplies," such as oil, waste, and the innumerable sundries required about a power plant; and fourth, the "charge for fuel," which to limit the scope of this discussion may be considered as coal. The sum of all these expenses, the total cost of power, may be apportioned to each horsepower year developed, irrespective of the size of the plant, and thus furnish a convenient unit upon which to base comparisons.

Of the four groups of factors, the most variable is that of fuel—the cost of coal. This may vary between comparatively wide limits, depending upon the locality of the power house, the grade of coal used, etc., but, for an analysis such as the one contemplated, arbitrary limits may be assumed. A minimum price of $2 per ton (2,000 lbs.) will be taken with a maximum of $5 per ton. The yearly tonnage consumed by the various plants will be taken as that required when burning coal of average good quality economically and efficiently, so that each plant may be investigated as to the cost of operation with any specific fuel charge unit between the assumed limits.

Actual total annual costs of power (averages) from a large number of

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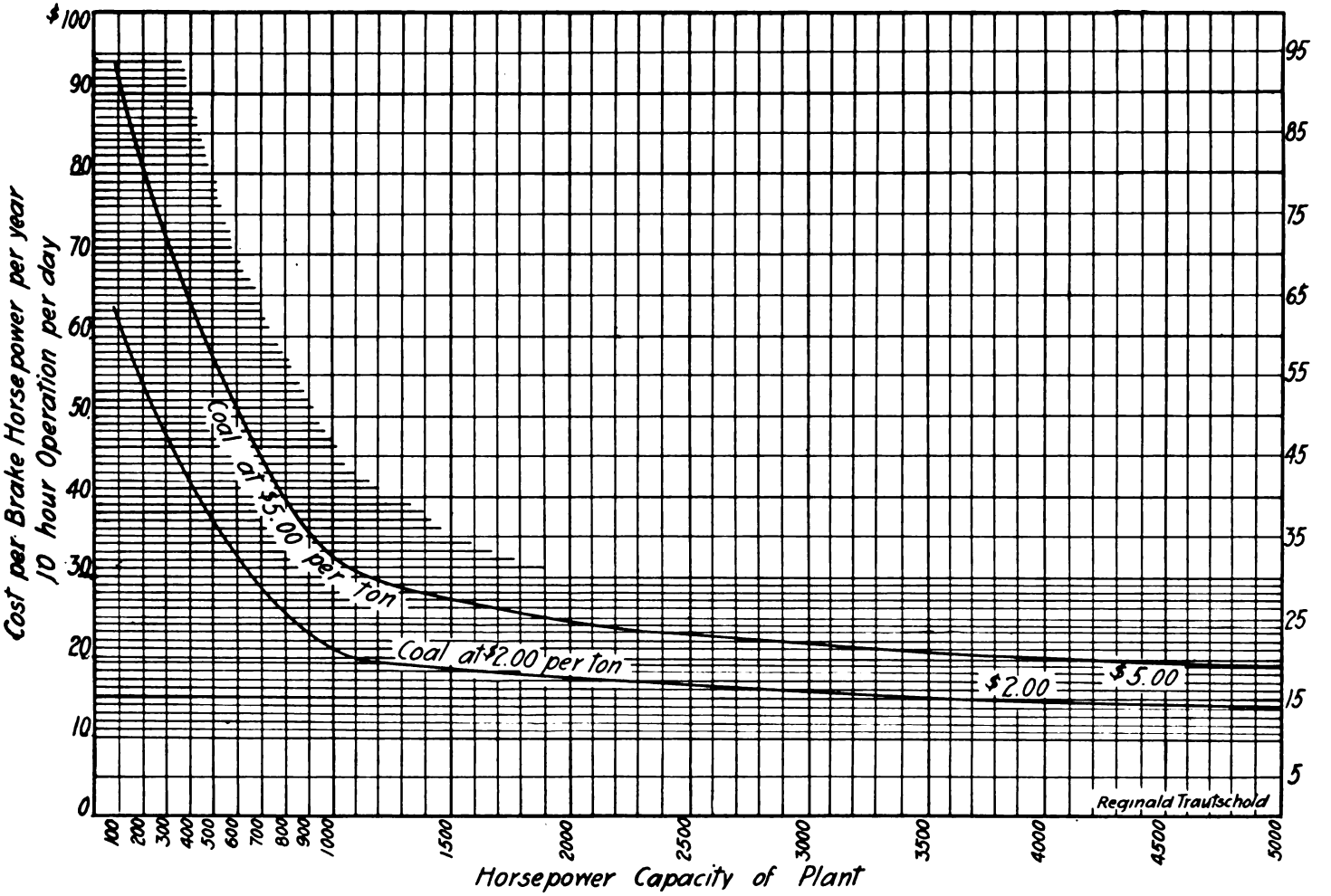

CHART 1. TOTAL AVERAGE ANNUAL COST OF STEAM POWER IN COAL-BURNING PLANTS
Cost at Engine.—No transmission or conversion losses considered

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CHART II. AVERAGE COAL CONSUMPTION IN STEAM POWER PLANTS

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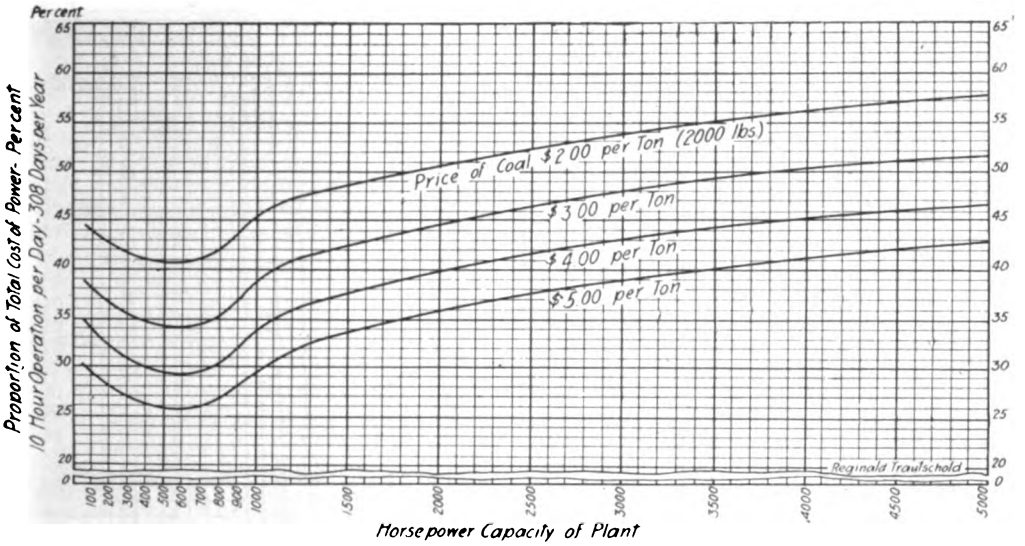
Percent
Proportion of Total Cost of Power- Percent
10 Hour Operation per Day - 308 Days per Year
Price of Coal $2.00 per Ton (2000 lbs)
$3.00 per Ton
$4.00 per Ton
$5.00 per Ton
Reginald Trautschold
Horsepower Capacity of Plant

CHART III. THE "FIXED CHARGES" FACTOR IN THE COST OF STEAM POWER
Comparative cost in coal-burning power plants

efficiently operated power plants situated throughout the country—plants running 10 hours per day, 308 days each year, or plant records reduced to such common condition of service —are used to plot the graphic presentation on Chart I, the various individual costs all falling between the curves marked "Coal at $5 per ton" and "Coal at $2 per ton"; the plants operating on the more expensive fuel approaching in total cost of power the upper curve, and those using cheap coal the lower curve. So uniformly do the various individual costs follow the curves that it is quite evident there exists a definite relationship between the average cost of power and the size of the plant, and also that the cost of coal has a very decided effect upon the total cost of power.

Analyzing the various factors affecting the cost of power and standardizing them by correcting as much as possible for differences in conditions of service, hours of service, and load demands, the average individual costs for various sizes of plants from those of 100-horsepower capacity to those capable of developing 5,000 horsepower are listed in Tables I, II, and III; while Table IV contains the average yearly tonnage of coal that should be burned in the various plants, if properly husbanded and efficiently used. The data of the latter table is also graphically depicted on Chart II, which clearly and strikingly illustrates the decided advantage of the large plant when it comes to a question of economic coal consumption, and particularly the handicap in the way of fuel expense that plants of less than 1,000-horsepower capacity labor under.

TABLE I

FIXED CHARGES PER BRAKE-HORSEPOWER YEAR
10-hour operation, 308 days per year

Size of Plant Brake-horse-power	Fixed Charges	Size of Plant Brake-horse-power	Fixed Charges
100	$26.66	900	$9.90
200	21.83	1000	9.23
300	19.30	1500	9.00
400	17.10	2000	8.75
500	14.85	2500	8.48
600	13.00	3000	8.25
700	11.70	4000	8.10
800	10.60	5000	7.76

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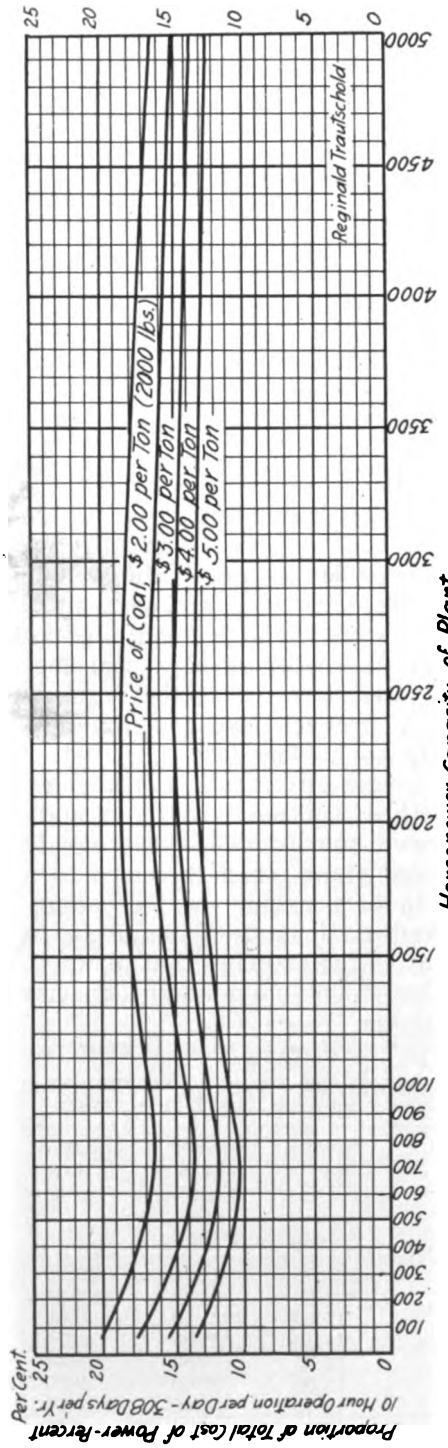

CHART IV. THE "ATTENDANCE" FACTOR IN THE COST OF STEAM POWER
Comparative cost in coal-burning power plants

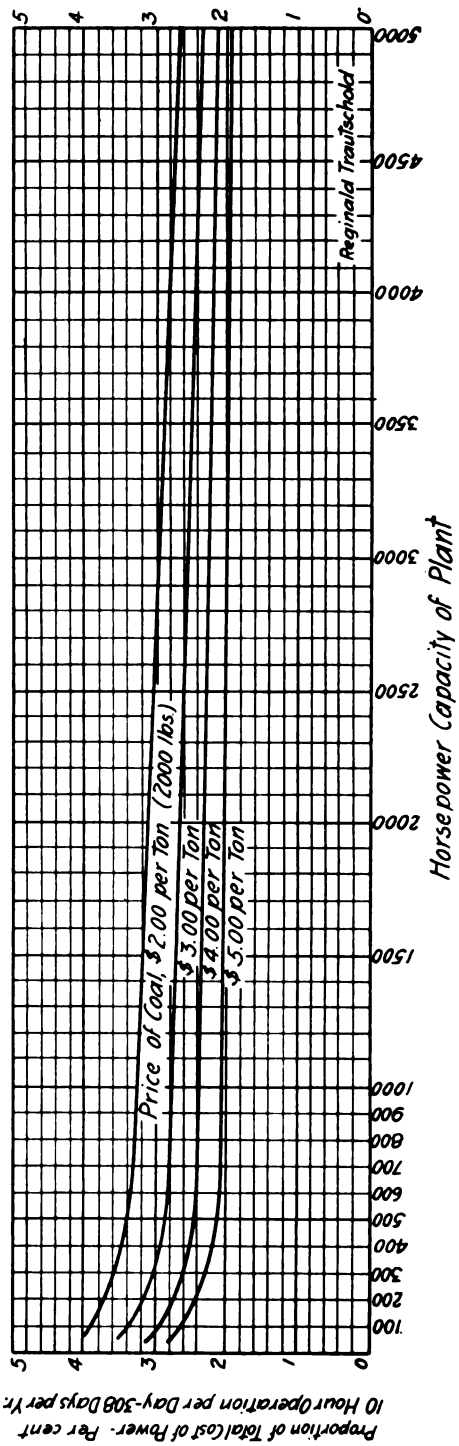

CHART V. THE "SUPPLIES" FACTOR IN THE COST OF STEAM POWER
Comparative cost in coal-burning power plants

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TABLE II

ATTENDANCE CHARGES PER BRAKE-HORSEPOWER YEAR

10-hour operation, 308 days per year

Size of Plant Brake-horse-power	Attend-ance	Size of Plant Brake-horse-power	Attend-ance
100	$12.10	900	$3.75
200	10.00	1000	3.40
300	8.50	1500	3.30
400	7.35	2000	3.16
500	6.20	2500	3.03
600	5.33	3000	2.77
700	4.65	4000	2.50
800	4.16	5000	2.23

The fact that the data of Tables I, II, and III are expressed in concrete figures—dollars and cents—is apt to hide their chief value, their applicability to power houses in general; for, being but averages which would probably seldom agree with actual results attained, the variations, slight though they may be, have a tendency to discount or discredit the value of the tables. The relationships of the various items to one another do not vary considerably, however, even though the concrete figures may apparently do so. As it is also possible to reduce the average annual coal expense to dollars and cents, knowing the amount of coal used and its price, all factors entering into the cost of power may be expressed in percentages of the total cost, with coal commanding any specific price, and thereby be more conveniently applicable to power houses in general. Particularly is this so if comparisons are made through the agency of plotted curves which smooth out the slight inaccuracies and by doing so depict practice which can be followed with impunity.

The "fixed charges" factor in the cost of power is graphically depicted on Chart III for plants in which the price commanded by coal is from $2 to $5 per ton. From this chart it is apparent that the most economical power house to erect, as far as "fixed charges" are concerned, is one with a capacity of from 500 to 600 horsepower; that plants of 1,000 horsepower or larger carry more of a "fixed charges" burden than even a small plant of 100 horsepower; and that this burden increases steadily but at a gradually lessening rate for plants of still greater capacity.

The "attendance" factor, see Chart IV, has quite a different effect upon the cost of steam power. It drops quite rapidly in proportional cost from that imposed on a small plant of 100-horsepower capacity or so to that carried by a plant of from 700- to 800-horsepower capacity in which it is about at its lowest. The attendance, then, becomes more of a burden as the size of plant increases until it reaches another high point in a plant of about 2,500-horsepower capacity, after which the attendance expense gradually becomes less and less of a proportional charge.

The "supplies" factor, see Chart V, decreases in proportional cost with the size of plant on the other hand, decreasing more rapidly in small plants than in larger ones, but showing a very uniform decrease in plants of over 1,000-horsepower capacity.

TABLE III

SUPPLY CHARGES PER BRAKE-HORSEPOWER YEAR

10-hour operation, 308 days per year

Size of Plant Brake-horse-power	Supplies	Size of Plant Brake-horse-power	Supplies
100	$2.38	900	$0.75
200	2.00	1000	.68
300	1.67	1500	.59
400	1.46	2000	.54
500	1.24	2500	.49
600	1.09	3000	.46
700	.94	4000	.40
800	.83	5000	.35

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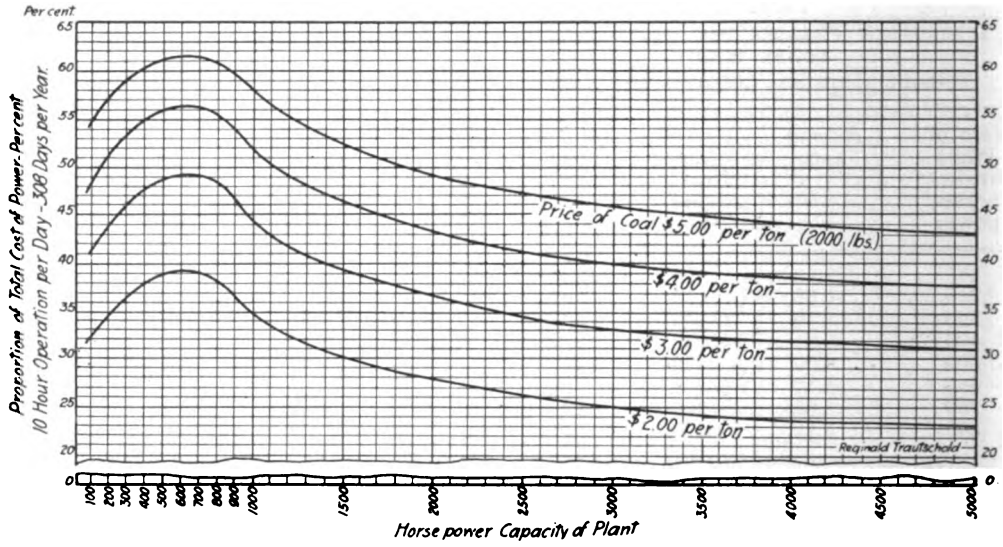
Per cent
Proportion of Total Cost of Power-Per cent
10 Hour Operation per Day - 308 Days per Year
Price of Coal $5.00 per Ton (2000 lbs.)
$4.00 per Ton
$3.00 per Ton
$2.00 per Ton
Reginald Trautschold
Horse power Capacity of Plant

CHART VI. THE "COAL" FACTOR IN THE COST OF STEAM POWER
Comparative cost in coal-burning power plants

The fuel expense for steam power plants, the effect of which on the cost of power is shown on Chart VI, has really the most marked effect of all factors upon the cost of power—effects that are not usually recognized and which are very nearly the opposite to the effects of the "fixed charges" factor. The coal burden increases quite rapidly in proportional cost in plants from 100-horsepower capacity up to plants having power equipment capable of developing 600 or 700 horsepower, although over this same range of power-house capacities the consumption of coal per horsepower decreases rapidly with any increase in the capacity of the power house. For plants of 900 horsepower or more, the coal burden (proportional) decreases gradually, the decrease being more marked in plants only slightly larger than 900-horsepower capacity than in plants considerably larger.

These vagaries of the factors affecting the cost of power make it quite obvious that the co-relationship of the factors is very different in power houses of different capacities, and also the relationship of the factors to assure efficiency and relative economy in operation is markedly affected by the unit cost of coal. In localities where the average price of suitable coal is $3 per ton, the "fixed charges" of a power house of 5,000-horsepower capacity would constitute over 51 per cent of the total cost of steam power, while the coal expense should not greatly exceed 31 per cent of the net cost of developing power, the balance of about 18 per cent being divided between the cost for attend-

TABLE IV
COAL CONSUMPTION PER BRAKE-HORSEPOWER YEAR
10-hour operation, 308 days per year

Size of Plant Brake-horse-power	Tons	Size of Plant Brake-horse-power	Tons
100	9.65	900	4.17
200	9.10	1000	3.56
300	8.45	1500	2.82
400	7.95	2000	2.44
500	7.10	2500	2.15
600	6.25	3000	1.92
700	5.55	4000	1.71
800	4.80	5000	1.58

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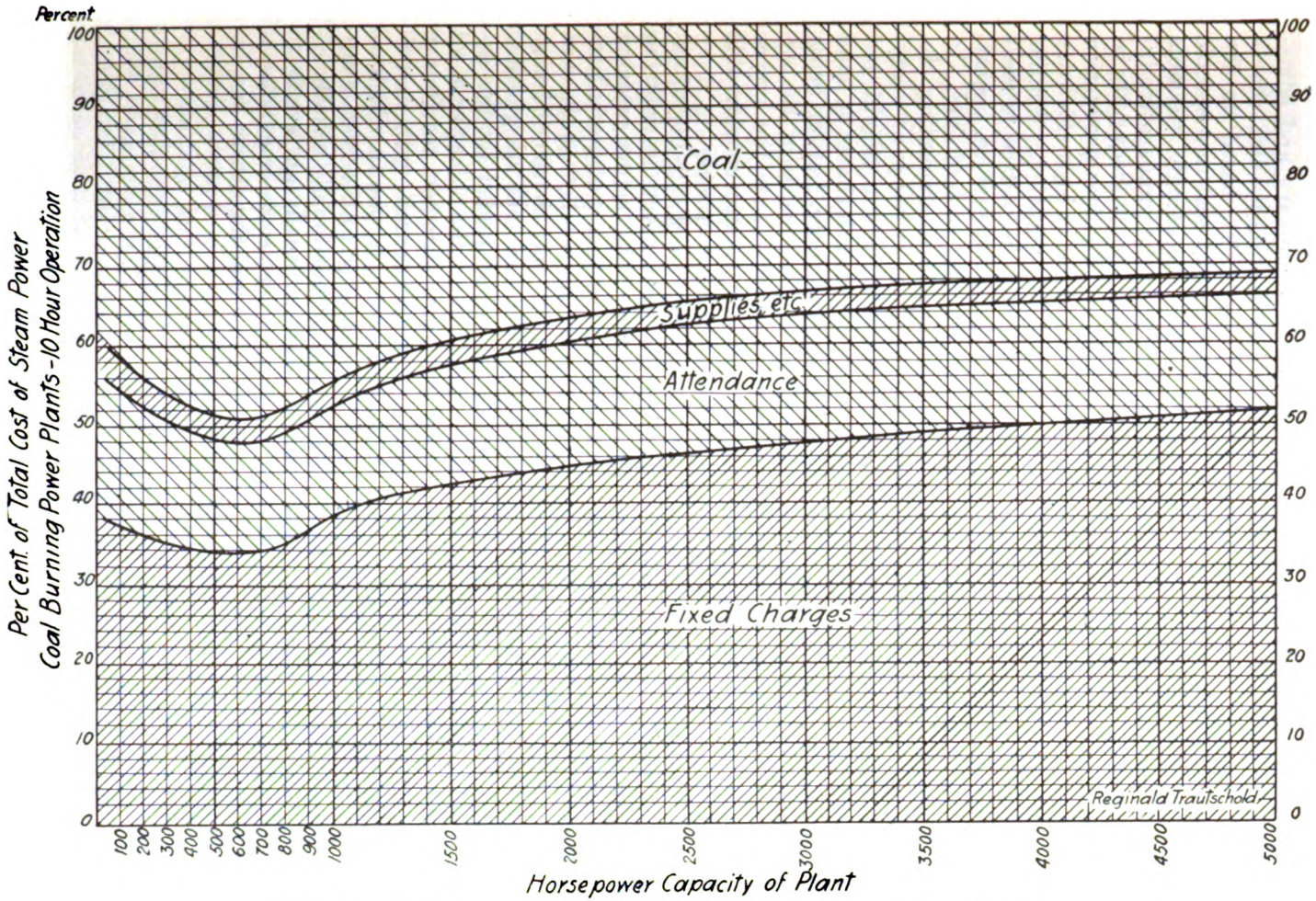

CHART VII. CO-RELATIONSHIP OF FACTORS AFFECTING THE COST OF STEAM POWER
Coal at $3.00 per ton

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ance and that for necessary supplies in a ratio of about 6½ to 1 (see Chart VII). To secure the same relative efficiency in a plant of about 600-horsepower capacity, the average price of coal remaining at $3 per ton, the "fixed charges" should not constitute much over 34 per cent of the total cost of power, while the coal expense would be close to 50 per cent of the whole cost. The required supplies would be proportionally slightly more expensive than in the larger plant, but the relative expense for attendance should be somewhat less.

A small plant of 100-horsepower capacity would again show quite different permissible apportionment of the various charges, if the same relative efficiency was maintained. The "fixed charges" in a power house of this size would be close to 40 per cent, the "coal charge" over 32½ per cent of the total cost of power, the necessary outlay entailed for supplies, etc., somewhat relatively greater than in the larger plants, and the "attendance charge" somewhat proportionally higher than in the 5,000-horsepower plant and considerably greater than in the case of the 600-horsepower power house. In fact, the co-relationship of the factors affecting the cost of power would vary for every size of power house,—the usual allowable variations being depicted on Chart VII for plants in which the average price of coal is $3 per ton—and, naturally, would again differ considerably with the average unit price of coal.

Naturally the proportions depicted on the foregoing charts, etc., cannot always be attained—considerable variation may be necessary and advisable in many instances—but charts similar to Chart VII, based on the average unit cost of coal in a specific locality, prove exceedingly valuable and convenient in the comparative investigations that should frequently be made of the cost of power production in all plants aiming at high efficiency and economy in operation. Similar charts can readily be plotted to meet any specific hours of service, operating conditions, and cost of fuel. In fact, every modern accounting department of a power house or manufacturing establishment should not only have a set of such charts at hand for frequent reference, but by being guided by reliable records of the experience of other plants the power house itself can realize considerable economies almost invariably.

There is always a possibility of expending too great efforts in reducing the cost of one of the factors entering into the question of cost of power production, with the result that the cost of other factors may thereby be augmented. This can best be guarded against by being guided by the experience of others, the objective of all being the same. The best results are almost always secured with a well balanced plant, i. e., one in which all factors pertaining to the cost of operation are proportionally equally efficient. This is usually preferable to a condition where some one factor is extremely low and the others less favorable.

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HANDLING MATERIALS IN MANUFACTURING PLANTS

By Robert L. Streeter

V. VERTICAL ELEVATORS—INCLINED ELEVATORS—PILING MACHINES

Vertical Transportation—this might have been given as the topic for the following installment of Professor Streeter's series,—vertical transportation of commodities as effected in the factory by means of both the intermittent or reciprocating "elevator," commonly so called, and the continuous or chain-type elevator, which operates both vertically and inclined. The many types of intermittent machines, as classified by the nature of their drive and of their control, are taken up seriatim and especial attention is devoted to their safety devices. The continuously running elevators include such machines as were not described in Part III, dealing with conveyors.—THE EDITORS.

ELEVATOR, as a term, through common use, has become associated with what is known in England as a "lift." Actually the word elevator is applied to several classes of machines, the most common being the platform or cage that ascends and descends vertically in a shaft. Other types are bucket elevators which have already been discussed in this series of articles, inclined elevators or escalators for passenger use, and inclined elevators for handling freight. These machines just mentioned are all used for carrying people or freight from one floor to another. Other types of machines that might be included in the category of elevators are those which are used for elevating freight through short distances, such as piling and tiering machines used for stacking freight in warehouses and for unloading and loading vessels, railway cars and wagons. Since this paper deals only with the handling of materials, the passenger elevator, interesting as it is, will not be given any space.

The machines that are used for elevating material in shops, warehouses, etc., might be classed thus:

Vertical elevators—hand power, belt power, plunger type (steam, compressed air, hydraulic), electric power.

Inclined elevators.

Piling and tiering machines.

HAND-POWER ELEVATORS

The hand-power elevator was the first to come into use, which, of course, was entirely natural. This machine was first patented in 1846. This type of elevator is used where it will be needed only infrequently and where the lift is not great. It certainly would not pay to install a hand operated elevator to serve more than three or four floors.

The hand-power freight elevator usually consists of a rope drum which carries the platform or cage and a "bullwheel" which is geared to the rope drum. The hand rope passes over the grooved bullwheel, the size of which depends on the capacity of the elevator, heavy loads requiring a larger wheel than lighter ones. The gear reduction also varies with the capacity of the elevator, being greater for the heavier machines. With very light machines,

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such as the dumbwaiter, the bullwheel is usually placed on the same shaft with the rope drum or sheave. In this case, then, the maximum load that could be lifted by one person would depend only on the relative size of the bullwheel and rope sheave.

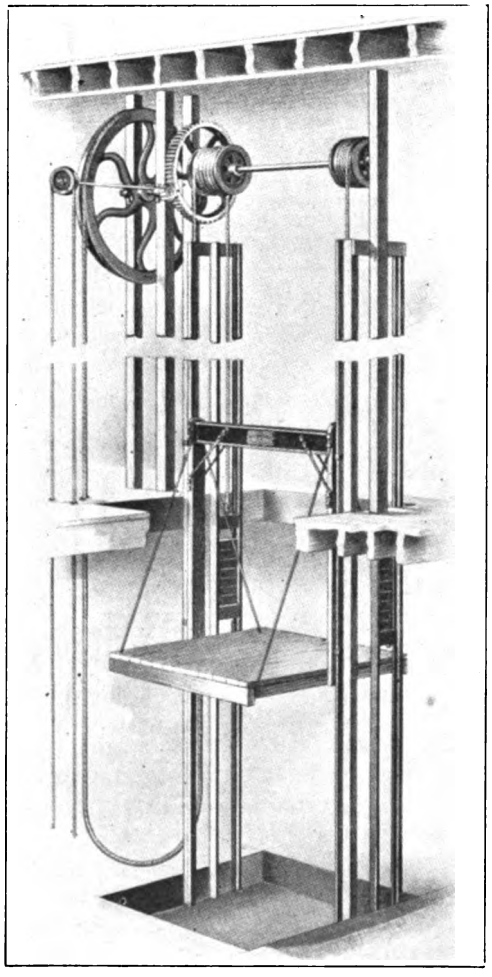

FIG. 1. HAND-POWER ELEVATOR
The H. J. Reedy Company

Carriage and automobile elevators are frequently made to operate by hand power. These machines usually have a lifting cable attached to each corner and the four cables wind on two drums placed on the same shaft directly over one end of the elevator. This shaft is geared to the bullwheel as in the ordinary type of hand elevator. The cables from the two corners of the elevator opposite the drums pass over two idler sheaves and thence to the drums so that each drum carries two hoist cables.

As a rule the hand-power elevators are not self-supporting at all loads. They are counterweighted as shown in Figure 1 and the counterweight should be heavier than the car so that the empty car will ascend. The brake that holds the car in position is on the bullwheel and is operated by the small rope illustrated in Figure 1. The rope passes over a sheave on a shaft alongside the bullwheel. On this shaft is a coarse thread which turns in a nut on the brake block, forcing it against or away from the bullwheel and thus tightening the brake or releasing it. The pull on the brake rope required to hold the car is small since the force necessary to hold the bullwheel with a full load is less than that which one man can exert. This brake is applied automatically as the elevator car approaches the top or bottom of its travel, or it may be applied automatically as the car approaches any floor level, thus stopping the car in the proper position.

Hand-power elevators are frequently used for hoisting material from a basement to the street level. In that type of machine the lifting device is placed in the basement and consists of a windlass operated by cranks through one or two pairs of spur gears. The one illustrated in Figure 2 has two pairs, the final gear being on the horizontal shaft which carries two chain drums. The platform in this type of machine may be held either by a ratchet or a band brake. In the one illustrated a band brake on the countershaft is used.

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Belt-Driven Elevators

In factories where the machines are belted to line shafts driven by a steam engine or a motor, or in places where it is not convenient to install an electric motor or a plunger to operate the elevator, a belt-driven machine may be used to good advantage. Such a machine driven by two belts, open and crossed, is shown in Figure 3. In this case the belt shaft is geared to the cable-drum shaft through a worm and worm wheel, the worm being cut in steel and the wheel in bronze. The end thrust on the worm is carried on ball thrust-bearings. Of the three belt pulleys shown, two are loose and one, the center one, is keyed to the shaft. The belt shifters are operated from the car by a rope which passes over the rope sheave shown on the side of the frame of the machine.

The fourth wheel on the belt shaft is the brake wheel, which is operated automatically with the starting rope; that is, when the rope is shifted to either the raising or lowering position, the brake is automatically released and when the rope is put in the stop position the brake is applied. Thus the car may be held in any position simply by the manipulation of the starting rope. An automatic safety device stops the car at the upper and lower landings in case the operator is negligent or the shifting cable becomes inoperative. In addition, there is a slack-cable device under the cable drum, which arrests the motion of the machine in case the car becomes obstructed in its descent, the machine always stopping with the car.

This machine, which is built in three sizes ranging from 1500 to 6000 pounds' capacity, is also made to be belted to a reversing motor in which case the two loose pulleys are dispensed with and one belt is used.

Piston Elevators

There are several types of elevators operated by means of pistons or plungers in cylinders. The fluid used may be steam, compressed air, or water. The cylinder is placed in

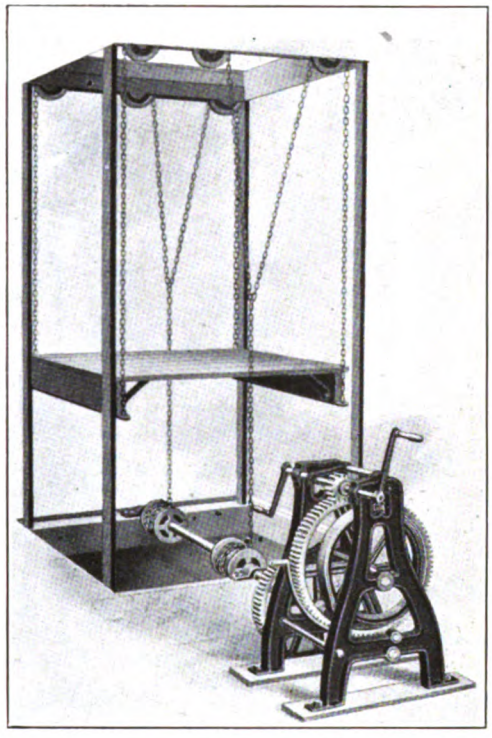

FIG. 2. HAND POWER SIDEWALK ELEVATOR
The H. J. Reedy Company

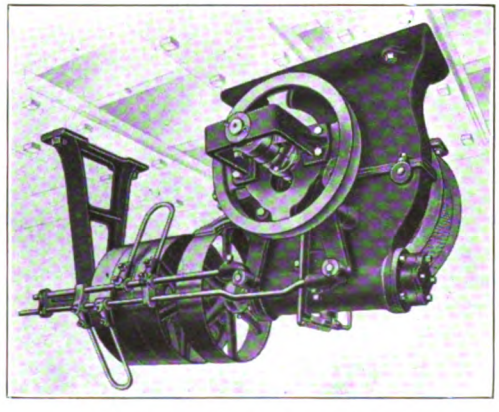

FIG. 3. BELT DRIVEN ELEVATOR
Made by the American Elevator and Machine Company, Louisville, Kentucky

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any one of several positions depending on the local conditions. The simplest method is to have the cylinder below the car, the latter resting on top of the plunger. This necessitates having a well of a depth equal to the lift of the car. This type, known as

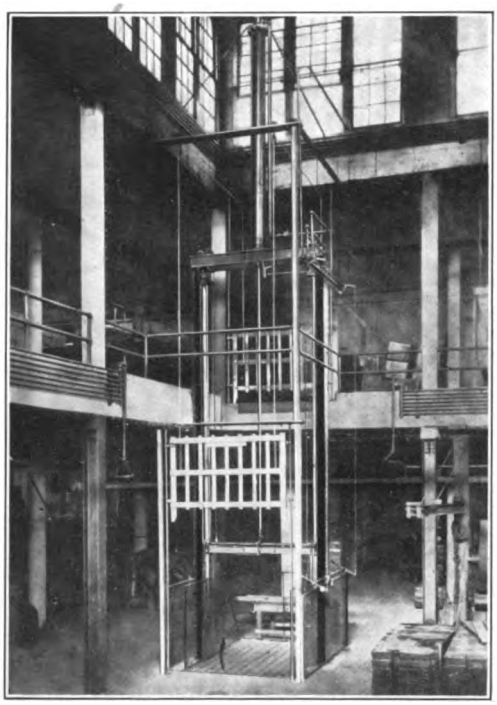

FIG. 4. CURTIS PNEUMATIC ELEVATOR FOR SHOP USE WHERE LIFT IS SMALL

the plunger elevator, has been highly developed and is used in some very tall buildings.

Another method is to have the cylinder directly over the car, in which case a piston rod projects through the bottom end of the cylinder and is fastened to the top of the car. Obviously this arrangement can be used only where the lift is small and where there is head room for the cylinder.

Still another arrangement is to have a vertical cylinder placed in a shaft alongside the elevator shaft. In this case the plunger carries a block consisting of several cable sheaves, the number depending on the ratio between the car travel and the plunger travel. In some instances the cylinder and plunger are horizontal instead of vertical.

The pneumatic elevator shown in Figure 4 is one of the simpler types made by Curtis and Company Manufacturing Company of St. Louis. This particular type, which is well adapted for lifting material through comparatively short distances, is made in eight sizes with capacities ranging from 1200 to 12500 pounds, using air at 80 pounds pressure. The diameters of the corresponding cylinders range from 6 to 17 inches. This company also makes a similar type of machine with the cylinder under the car, in which type the capacities range from 1100 to 5000 pounds with diameters of cylinders from 6 to 12 inches. The company also manufactures a rope type with the cylinder in a vertical position alongside the elevator shaft. This last type is built in seven sizes from 1100 to 8000 pounds' capacity. The cylinder diameter of the smallest is 8 inches and that of the largest is 19 inches.

The cylinders of the pneumatic elevators mentioned above are of the balanced type, that is, there is constant air pressure on the hoisting side of the piston; air is exhausted from the opposing side to hoist the cage, and admitted to the opposing side to lower the cage. Pneumatic cushions in each end of the cylinder, independent of valve or hand chain, gradually slow up the cage and rubber buffers bring it to a stop at the top and bottom. The speed control of this elevator is automatic and is entirely independent of the operator, since it is placed in the line between the air valve and the cylinder. A safety latch is provided to prevent overloading the elevator. If a load

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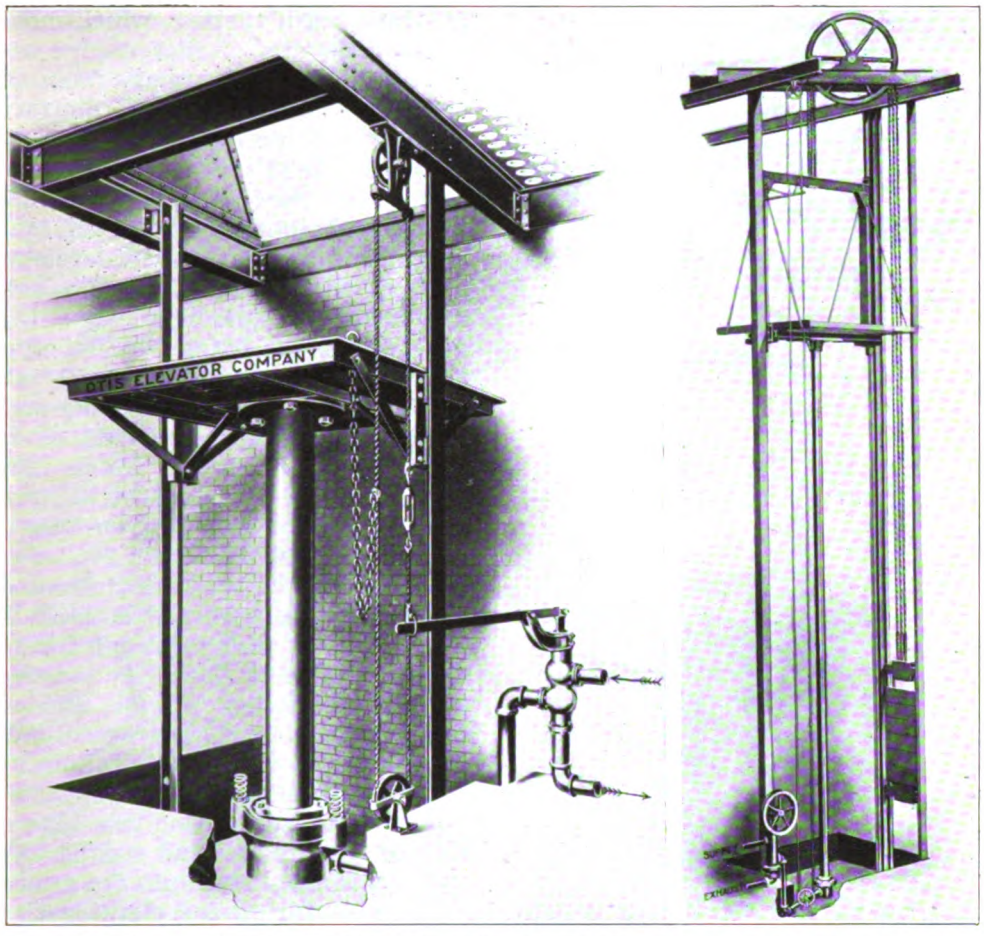

FIGS. 5 AND 6. OTIS PLUNGER TYPE SIDEWALK ELEVATOR AND FREIGHT ELEVATOR

greater than the capacity of the machine is put in the cage at the bottom of its travel no trouble results, since the elevator just naturally refuses to lift it. If, however, the machine is overloaded at an upper floor, the cage settles a short distance and rests on a safety latch, which holds the air valve closed until some of the load is removed, so as to allow the constant pressure on the hoisting side of the piston to lift the cage free of the safety latch.

Hydraulic elevators came into use about fifty years ago and have since been developed in many forms. The simplest type for a short lift is that shown in Figure 5, a direct-acting plunger sidewalk elevator, so named because it operates from the basement to the street level. The water supply for this, or any other type of hydraulic elevator for that matter, may be from city mains, roof tank, or pressure tank placed at any convenient point. The operating valve is shown at the right. This is a simple valve which, when lowered by raising the lever, admits water into the cylinder, raising the plunger and load. When the plunger nears the top of its travel, the chain attached to the platform and to the operating rope pulls taut. This low-

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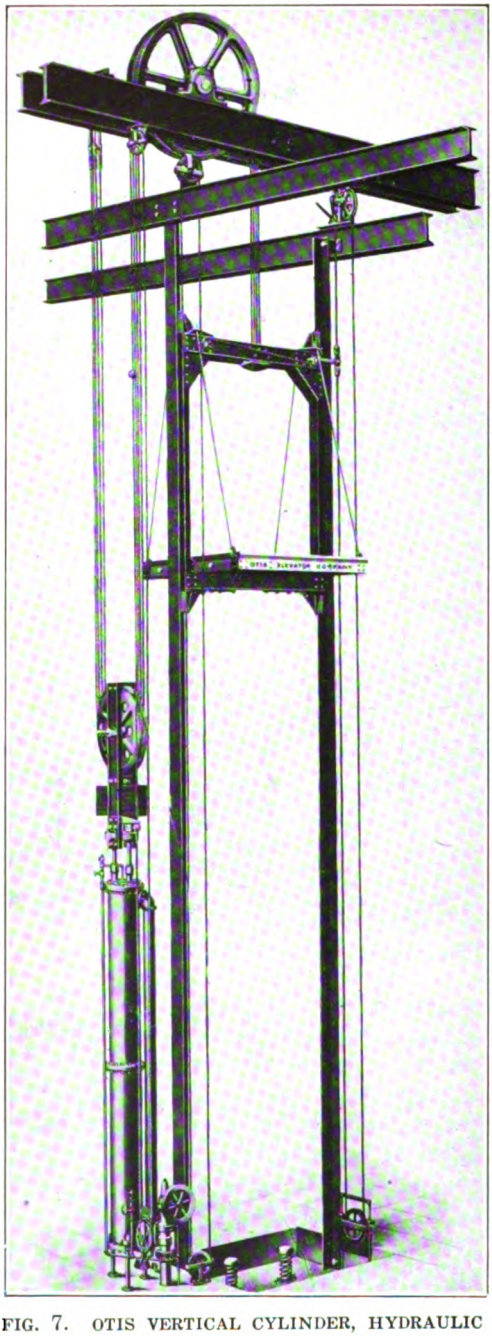

FIG. 7. OTIS VERTICAL CYLINDER, HYDRAULIC GEARED FREIGHT ELEVATOR

ers the lever to its central position and both the inlet and outlet ports of the operating valve are closed. In order to lower the elevator the lever is lowered still further, which movement opens the discharge pipe and allows the water to empty from the cylinder, the plunger and platform settling into the bottom position.

About 1882 the direct-acting plunger or ram elevator came into use for buildings of considerable height and has since been developed until at the present time it is used in some of our tallest buildings. One great advantage claimed for this type of elevator is that it is almost absolutely proof against dropping accidents. This may be understood by referring to Figure 6, which illustrates an Otis plunger freight-elevator. It will be seen that so long as the cylinder, plunger, and piping remain intact, the speed of descent of the elevator is governed entirely by the velocity of water through the operating valve. There is another greater possibility of an accident and, strange as it may seem, it is the danger of the elevator falling up. This will be explained later.

The disadvantages of this type of elevator are its cost and weight. The cylinder must extend into the ground at least as far as the elevator rises above the ground. It must also be heavy and water tight to withstand the great pressure used, in some cases as much as 700 pounds per square inch. The plunger, although it is made hollow, is of great weight and must be jointed carefully to avoid leaks. The great weight of the plunger, which in some cases is 500 feet long, necessitates heavy counterweights. These counterweights, as is shown in Figure 6, are attached to the top of the car by means of several wire cables, as many as six in some cases. Each of these cables may weigh as much as one pound per foot so that when the elevator rises one foot the increase in the counterweight will be

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12 pounds. As the cage nears the top of its travel the weight of the counterbalance has increased until there is tension in the plunger instead of compression. This condition caused a break in the plunger in a certain installation in an Eastern city some years ago and the car crashed through the roof with fatal results. Another disadvantage of this type of elevator is that the inertia of the great weight involved causes large stopping and starting stresses on the structure, but, on the other hand, the weight is responsible for smooth starting with an absence of jerk or jar. The difficulties and disadvantages of this type of elevator have been largely overcome by careful design and manufacture, so that now it is very largely used for passenger as well as freight service and in very high buildings.

The elevator known as the hydraulic geared type is shown in Figure 7. In this one the weight of the plunger must equal twice the weight of the car, plus the load. This plunger is held up by the pressure of the water; if the load is lifted, the pressure of the water is released from the cylinder under the plunger and the water allowed to escape when the excessive weight of the plunger over that of the car will lift the car and load. When the car descends it is necessary to produce a pressure in the cylinder great enough to lift this ram or plunger and allow the car to descend. The elevator shown in Figure 7 is geared 2 to 1, that is, the car moves 2 feet for each foot of travel of the plunger. In some cases where rapid travel is a prime requisite the gearing is 3 to 1. In this type the operating cylinder is inverted, the plunger passing through the bottom head.

As the number of reductions increases, the pressure of the water necessary to lift the load increases with a cylinder of given size. If we assume a total load of 8000 pounds to be lifted with a plunger 8 inches in diameter, the pressure necessary with the direct plunger type will be 160 pounds per square inch. With the same load and cylinder the pressure in the 2 to 1 geared machine would have to be 320 pounds, and in the 3 to 1 type 480 pounds. In the last type the pressures used sometimes run as high as 1000 pounds.

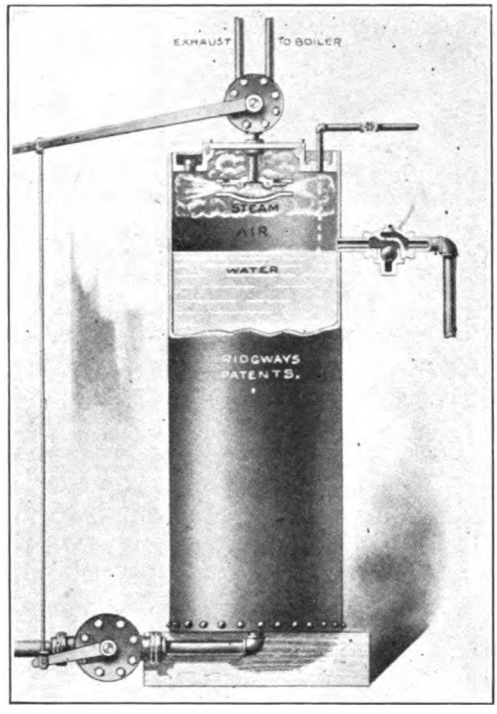

FIG. 8. THE STEAM-WATER DISPLACING DRUM OF THE RIDGWAY STEAM-HYDRAULIC ELEVATOR

In the hydraulic geared elevator, whether it be of the 2 to 1 or 3 to 1 type, the car will ascend with excessive speed if there is a break in the water pipes or the cylinder, thus allowing the water to escape. On the other hand if the ropes or sheaves give way, the car will descend. This necessitates safety devices operating both ways.

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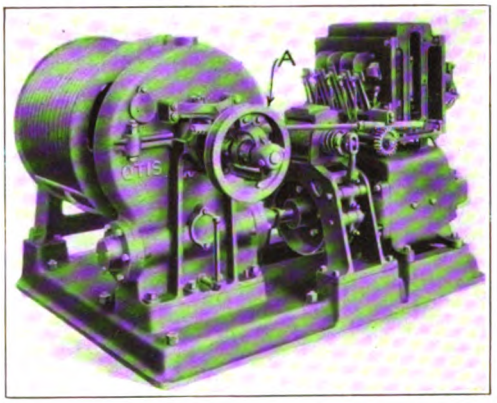

FIG. 9. OTIS SINGLE WORM AND DRUM FREIGHT ELEVATOR, ARRANGED FOR ROPE CONTROL

Another type of hydraulic elevator is the horiontal multiple-sheave elevator. This type is generally placed in the basement of a building on the floor and consists of a large cylinder with a piston, a connecting-rod and a set of multiple sheaves mounted on a cross-head traveling on a track. On the other end of the cylinder is also placed a set of sheaves, equal in number to those which travel with the piston and connecting-rod, and as the water is admitted into the cylinder between the head and plunger it moves the plunger out, thus pushing the plunger and sheaves upon the cables passing around these sheaves. Since the other ends of the ropes are attached to the cylinder, this motion of the piston lifts the car. In this type of elevator the car is counterweighted to within a point where the weight of the car will overcome the water in the cylinder, and when the exhaust valve is opened to lower the car, the weight of the car must be sufficient to force the water out of the cylinder into the tank, from which it is taken by the pumps and forced again into the pressure tank. This latter is the almost universal type of hydraulic elevator used for passenger service in high buildings and for freight service where high speed is demanded. The speed and lift depend only on the pressure of water which it is advisable to use or upon the maximum feasible diameter and stroke of the cylinder.

The pressure used in hydraulic elevators may be secured from city mains, tanks on the roof or from pressure tanks which are supplied by steam or electric pumps. For small installations city pressure may be used to good advantage where the cost of the water is not prohibitive and where the pressure is high enough so that it will not be necessary to use a plunger so large as to be unwieldy. Direct-acting steam pumps are sometimes used to furnish the necessary pressure for elevator service, as they are cheap, simple and require little attention. They are very wasteful of steam, however, and many substitutes for them have been proposed, some of which are successful. One of the successful ones is the "steam-hydraulic" system used by the Craig Ridgway and Son Company, of Coatesville, Pa. The fundamental part of this particular system is a cylinder or drum from which the water is displaced by means of steam admitted at the top as shown in Figure 8. It is a well known fact that steam brought into contact with water of a lower temperature is quickly condensed. The condensation is prevented in this case by a stratum of air between the water and steam, which prevents direct contact of the two and also forms a non-conducting medium between them. The presence of this air, which is very necessary for the proper working of this system, is assured by the inverted ball check shown at the right. When steam or compressed air under pressure is admitted to the top of the cylinder, the ball is lifted and closes the opening to the atmosphere. When the steam or air is exhausted,

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the ball drops and permits any excess water to escape and a volume of air to enter.

The action of this elevator may be briefly described as follows: When the elevator is at the bottom of its shaft, the plunger has displaced the water from the working cylinder and forced it into the displacing drum so that the condition of the drum will be as shown in Figure 8. To raise the elevator the operating cable shown at the left is pulled up. This operation admits steam to the top of the displacing drum and at the same time opens the valve which allows water to flow from the bottom of the drum to the working cylinder under the same pressure as the steam. To stop the elevator the operating cable is lowered, which operation shuts off the steam and closes the valve between the lifting clyinder and the displacing drum. The water is thus trapped in the working cylinder and the elevator is held in place. In order to lower the elevator the operating cable is lowered still further. This opens the steam exhaust valve allowing any steam that remains in the top of the displacing cylinder to be exhausted and at the same time the water flows from the operating cylinder back into the displacing drum.

The advantages claimed for this system are its simplicity, its superior efficiency compared to the direct-acting steam pump, and the fact that the pressure of the steam and consequently that of the water used varies directly with the load. Tests made at the plant of the California Electric Light Works show an advantage of the steam-hydraulic over the direct-acting steam pump of about 60 per cent in the steam consumption. One disadvantage of the steam-hydraulic system is that the maximum water pressure possible is only equal to the steam pressure available.

Electric Elevators

An electric elevator consists fundamentally of a car, a counterweight, hoisting cables, a motor which drives the sheave or drum about which the hoisting cables wind, and a controller. In some cases the controller is operated by electro-magnets, which in turn are actuated by a master switch in the car for regulating the starts, stops, and speeds of the elevator. In others the master switch is not used but the controller is operated by means of a hand rope which passes up through the car.

The first electric elevators were confined entirely to the drum type of machine, that is, a machine with a grooved drum about which the hoisting cables are wound and which is driven through worm gearing by an electric motor. This type of machine was highly satisfactory until, with the advent of steel skyscraper construction, buildings were designed 200, 300, 500, and even 700 feet high. For buildings of such heights the drum type of machine was found wholly inadequate, not only because of the very large drums necessary to accommodate the cables of these high-rise elevators, but also because of the practical limitations of this type.

To overcome the difficulties met with in trying to use the drum type of machine for high lifts, the traction elevator was perfected. This elevator derives its name from the fact that motion is obtained by means of the traction existing between the driving sheaves and the hoisting cables. In order to produce the necessary tension for this result the hoisting cables, from one end of which is suspended the car and from the other end the counterweight, pass partially around the traction driving sheave in lieu of a drum, continuing

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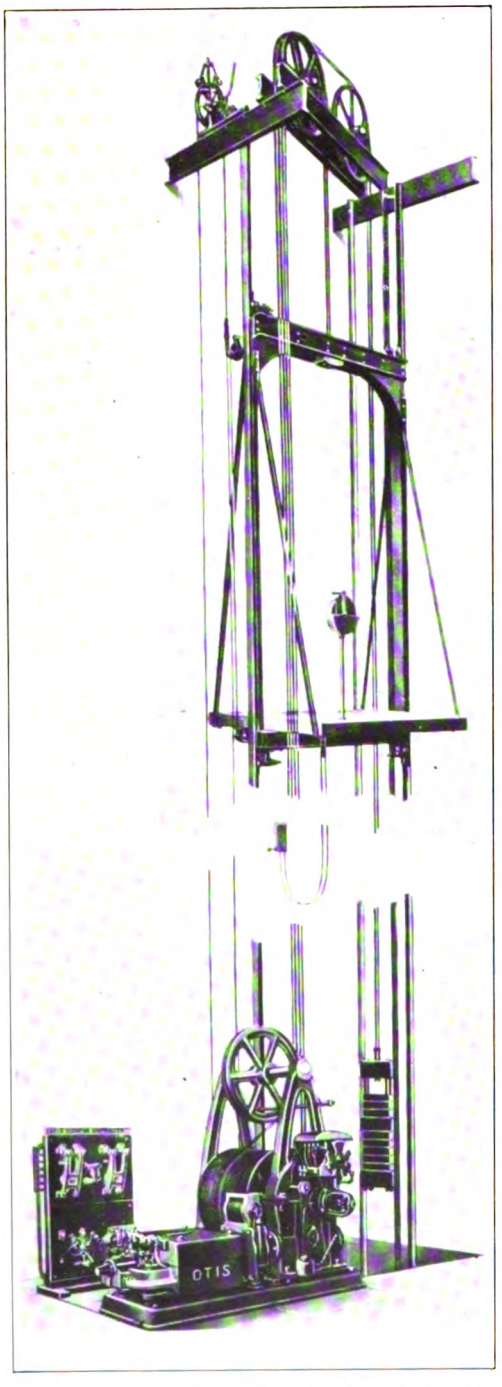

FIG. 10. ARRANGEMENT OF FREIGHT ELEVATOR WITH HOISTING UNIT AT BOTTOM OF SHAFT—WORM GEAR MACHINE

around an idler leading sheave and back around the driving sheave again, thereby forming a complete loop around these two sheaves.

The system of roping just described is known as the 1 to 1 gearless roping, the motor being on the sheave shaft. Another arrangement with the motor and sheave on the same shaft is known as the 2 to 1 gearless roping. In this type one end of the cable is fast to the counterweight, as in the 1 to 1, and the cables pass over the driving and idler sheaves in the manner already described. Instead, however, of having the other end of the cable fastened directly to the car, it passes around an idler sheave on the car and is fastened to the framework of the elevator just below the hoisting sheave. Thus the car hangs in a loop, and it will be readily understood that with a given motor speed and sheave diameter the speed of the 2 to 1 roping will be just half that of the 1 to 1 roping and if the weight hoisted is the same, the rate of power consumption for a given lift will also be half that necessary for the 1 to 1 type.

These gearless types of elevators have been developed primarily for high-speed passenger service and are used infrequently for freight service. The types used for freight service are those in which the winding drum or sheave is geared to the motor in one of several ways. These may be classified as follows: First, worm gear; second, worm and spur gear; third, spur gear (herringbone type).

The worm-gear machine with a single worm is shown in Figure 9. This particular type is for use in freight service, the hoisting unit to be located at the bottom of the shaft as shown in Figure 10. In the smaller sizes of these machines, such

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as dumbwaiters, the duties are from 500 pounds at 100 feet per minute to 100 pounds at 500 feet per minute; in the larger sizes, rarely exceeding 10,000 pounds at 150 feet per minute or 4000 pounds at 400 feet per minute.

These machines should be assembled with one bed plate for the entire machine in order to preserve alignment. The face of the coupling which connects the motor to the worm shaft is used as a brake pulley. The worm and shaft are in one piece of high-grade steel, the worm having cut teeth. The wormwheel has a bronze rim attached to a cast-iron spider. This spider is bolted directly to the sheave or drum in order to dispense with keys. Ball bearings are used to take the thrust of the worm. The worm, wormwheel, and thrust bearing are enclosed in an oil-tight housing and the worm is half submerged in oil. A mixture of pure vegetable castor oil and a good grade of mineral oil is the most suitable lubricant.

The worm type of machine is often made with a double worm, one right hand, the other left. The two worm wheels with which these worms mesh are usually so arranged that the two wheels constitute a pair of gears, being meshed together. This arrangement, illustrated in Figure 11, gives additional strength over the single worm and is used in high-duty machines for freight and passenger service.

The worm-and-spur-gear machine, Figure 11, is used for freight service and for passenger service where an elevator must be used occasionally for lifting heavy loads at low speeds, such as safe-lifts in office buildings. When such a machine is used as a passenger elevator the spur gear is not used, the wormwheel being connected directly to the sheave or drum. When it is necessary to lift

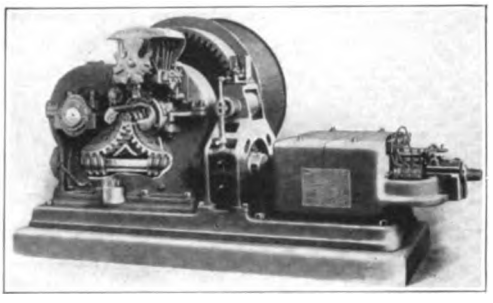

FIG. 11. OTIS DOUBLE-WORM AND SPUR GEAR ELEVATOR

a safe the coupling is removed and the spur gears placed in mesh, reducing the car speed and increasing the lifting capacity in proportion to the ratio of gearing in the spur gears.

Spur gears of the herringbone type are used on high speed machines in single reduction, where the car speed does not exceed 600 feet per minute. For the large lifting capacities and low speeds required in freight service, two reductions are used, the first being with helical and the second with either helical or straight teeth.

The motors used for elevator service were originally of the direct-current type, but in the last few years alternating-current machines have been developed to such a point of efficiency that they are very satisfactory. Elevator motors should be built especially for the service; to withstand the stresses due to frequent stopping and starting; they must have perfect commutation and heavy starting torque with a minimum starting current. To reduce starting current, direct-current motors are usually arranged to start as compound-wound machines with heavy series field, which must be cut out as the motor speeds up. The starting torque is usually twice the normal and the starting current one and one-quarter times the normal. For car speeds of over 100 feet per

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minute motors should be capable of speed reduction by means of field control to facilitate smooth and accurate stopping. For economy of power consumption, starting resistance should be cut out as fast as the load on the motor permits. Devices for this purpose are operated by series relays or employ the counter electro-motive force of the armature for their operation. In the former arrangement one or more magnets are in series with the armature and are so adjusted that their movable cores rise with the rise of current in the armature and remain suspended until, through acceleration of the motor, the armature current drops below a predetermined amount. This method is employed to energize consecutively a number of magnets which cut out the starting resistance in steps.

Counter electro-motive force, which builds up as the motor accelerates, is used for actuating magnets which consecutively short-circuit the starting resistance in proper relation to the speed and load. The number of these magnets depends on the size of the motor. Accelerating magnets controlled by series relays or counter electro-motive force automatically guard against excessive overload, as they will not operate unless the load is such that the motor starts at the making of starting connections.

In stopping direct-current elevator motors the first slow down is obtained by means of field control, generally applied to large motors, and the second slow down to a definite speed is obtained by armature series and shunt resistance. The latter may be applied in several steps, depending on the speed and load of the elevator car. The third slow down is obtained by dynamic action of the motor, produced by a resistance connected across the armature. This resistance may be automatically varied in successive steps in proper relation to speed and load. The final retardation and holding at stop is obtained by application of the brake. One or more of the preceding retarding effects may be omitted in small machines, particularly for slow car-speeds.

Alternating-current motors have no dynamic braking effect, except in the case of two-speed induction motors, and therefore rely entirely on mechanical braking effect for retardation. Two- or three-phase induction squirrel-cage motors are used, but they have a relatively high starting current; this may be reduced by increasing the internal rotor resistance, with a corresponding increase in slip, variation in speed due to load, and decrease in efficiency. This type of motor takes the maximum starting current at each start, irrespective of load.

Alternating-current motors of the two- or three-phase slip-ring type are also used for elevator work. The starting current is reduced by means of external resistance in the rotor circuit. The total external rotor resistance is greater than that required to give the starting torque necessary for starting the full load. This arrangement reduces the first inrush of current to a predetermined amount, which can be made much less than the first inrush required for the squirrel-cage motor, and in case the starting current is not sufficient to start the load imposed the rotor resistance will be automatically short-circuited until the required starting torque is obtained.

Two-speed alternating-current motors have been successfully employed, principally for higher car speeds and for conditions where accurate floor stops are necessary. This motor is electrically retarded to a predetermined speed, about one-third to one-

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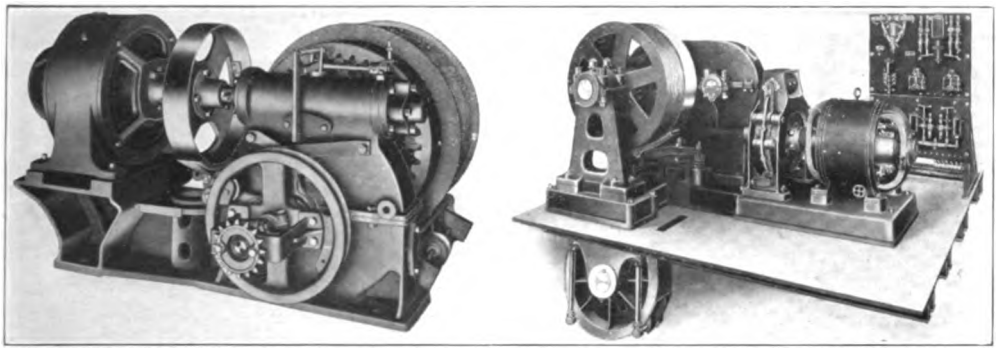

FIGS. 12 AND 13. HEAVY DUTY AMERICAN ELEVATORS

At the left, heavy duty, slow speed elevator arranged for hand-rope control. At the right, arrangement of machinery and control apparatus for heavy duty elevator.
American Elevator and Machine Company

fourth full speed, and the final stop from this speed is accomplished by the brake in the usual manner for alternating-current elevators.

Single-phase motors are built for car speeds not exceeding 150 feet per minute. These motors start as repulsion motors and at about 80 per cent of full speed a centrifugal governor short-circuits the commutator bars, after which the motor runs as an induction motor. The motors are not successful in sizes above 15 horsepower.

All electric elevators should have magnetically operated brakes to apply the brakes positively in case of failure of current supply. An arrangement called the slack-cable device is usually employed to prevent unwinding the cable from the drum in case the elevator is obstructed in its descent.

The simplest of such devices, but one that requires a magnetic circuit-breaker, consists of an apron close to the ropes under the drum, arranged to open a switch if the ropes get slack on the drum. This switch is in series with a circuit-breaker magnet which opens the line when the apron switch opens.

The controlling devices used on electric elevators fall into three classes, hand-rope control, magnet control, and push-button control. The hand-rope arrangement consists of an endless rope, one side of which passes through the car, wound with a few turns around a control sheave and attached to it. Hand-rope control becomes difficult to manage at high car-speeds and it is not generally used above 150 feet per minute. In Figure 9 the hand-rope sheave *A* is connected to the electric controlling devices by means of a rod, two pinions and two racks. Figure 12 also shows a hand-control machine. This particular arrangement is for either direct or alternating current and is built in capacities up to 6000 pounds, with speeds ranging from 25 to 80 feet per minute. The internal gear shown is used only for the larger capacities and slower speeds.

The magnet control is suitable for all car speeds and, next to the push button, it is the most convenient. All motor circuits are made and broken by magnetically operated switches, which in turn are controlled by a master switch in the car. Connection from the master switch to the controller is had by means of a flexible cable hung from the car to a junction box at the center of the hatch.

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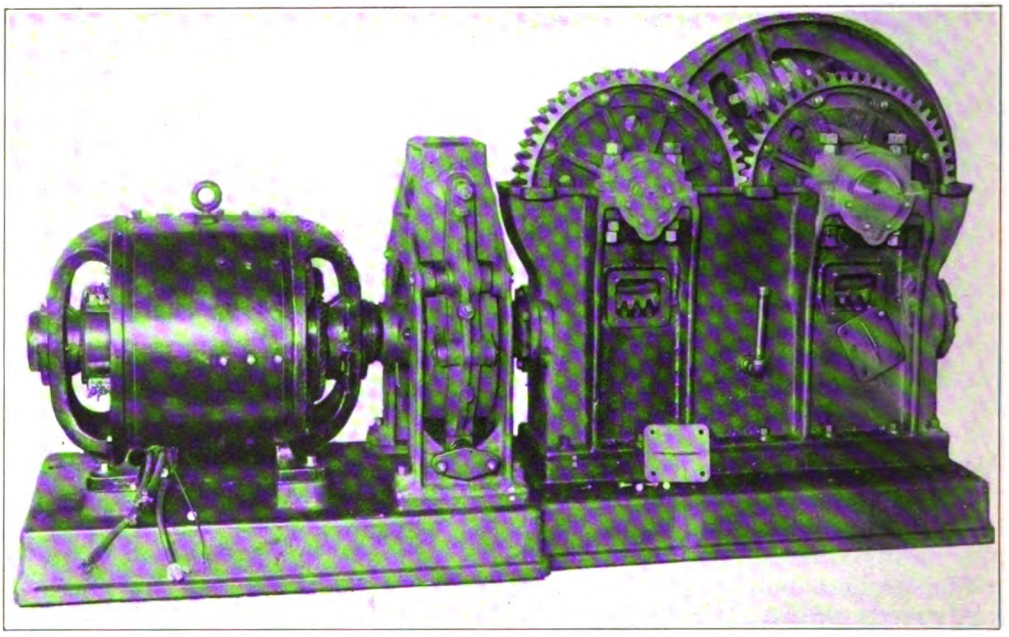

FIG. 14. THE SAME MACHINE ILLUSTRATED IN FIG. 13 WITH COVER OF GEAR CASE REMOVED —AMERICAN ELEVATOR AND MACHINE CO. HEAVY-DUTY MACHINE

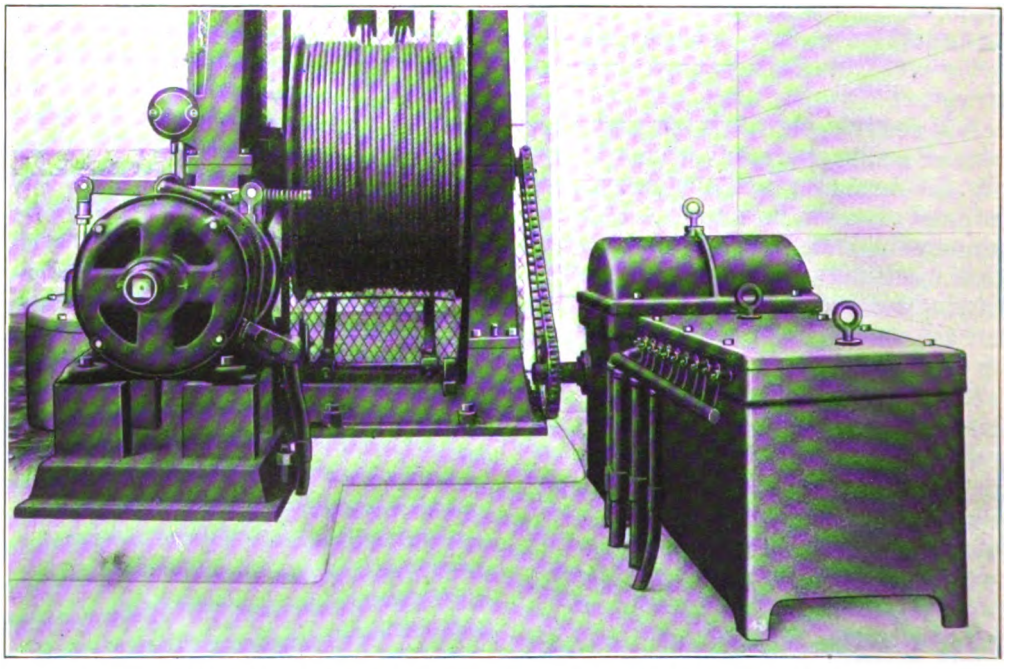

FIG. 15. AMERICAN ELEVATOR AND MACHINE COMPANY'S PUSH-BUTTON CONTROL MECHANISM FOR ALTERNATING CURRENT

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The arrangement of this type of control at the motor is shown in Figure 13, which illustrates an American tandem-geared traction elevator built for loads of from 2000 to 10000 pounds and speeds of from 450 to 75 feet per minute. The same machine with the gear-casing cover removed is shown in Figure 14.

The push-button control is a special type of magnet control which enables the car to be started and stopped by the pressing of a button. Usually there is one button located at each floor and a number of them in the car corresponding to the number of floors. The stopping of the car at a certain floor is accomplished by pushing the button corresponding to that floor. Figure 15 illustrates a push-button-control mechanism and full equipment for two- or three-phase alternating current. The controlling devices operate immersed in oil, which eliminates the noise, humming and pounding of switches and the burning of contacts.

Safety Devices

The safety devices used on elevators should be numerous enough to take care of any and every emergency and those used should be above reproach. In general these devices include: First, the mechanical brake that is applied to the worm shaft and holds the car at any point; second, an electric device to open the main-line circuit and apply the brake should the current be interrupted for any cause whatever; third, the slack-cable device to cut off the current and apply the safety brake should the car become obstructed in descending; fourth, the automatic-limit switches actuated by the car at the upper and lower limits of travel; fifth, buffers to bring the car or counterweight to an easy stop should the operator be negligent or should other safety devices fail. The type of buffer furnished by the Otis Elevator Company is illustrated in Figure 16. These buffers are placed in the hoistway, one under the car and one under the counterweight, and are arranged to bring either the car or the counterweight to a gradual and positive stop through the displacement of oil in the buffer at a carefully calculated rate of retardation, this being regulated by the escape of the oil from one chamber to another. A device of this kind is particularly valuable in the traction type of elevator; for in that type the cables are so arranged that should either the car or the counterweight stop at the bottom of its travel, the cables slip in the grooves of the driving sheave until normal conditions are resumed. It it always so arranged that the counterweight will strike the buffer before the car is at the top of the shaft. This prevents any accident due to pulling the car up to the drum, on

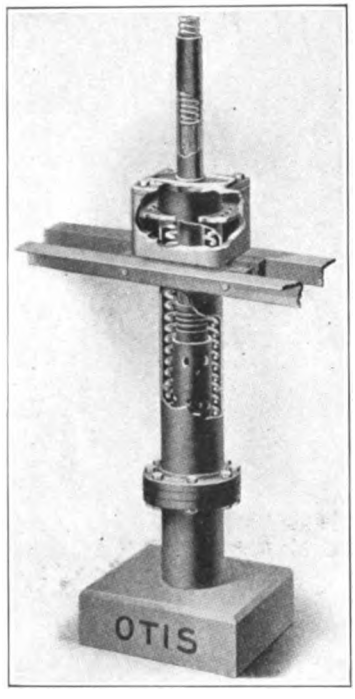

FIG. 16. OTIS OIL BUFFER USED UNDER ELEVATOR CAR AND COUNTERWEIGHT

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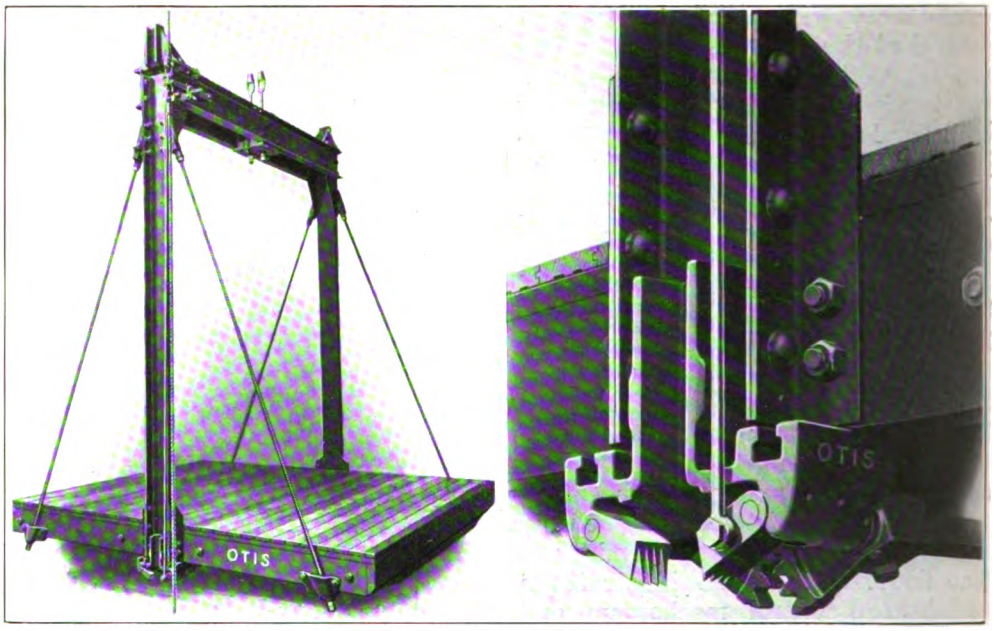

FIGS. 17 AND 18. OTIS FREIGHT ELEVATOR

At the left, elevator fitted with double grip safety for wood guides. At the right, details of safety grip shown at left

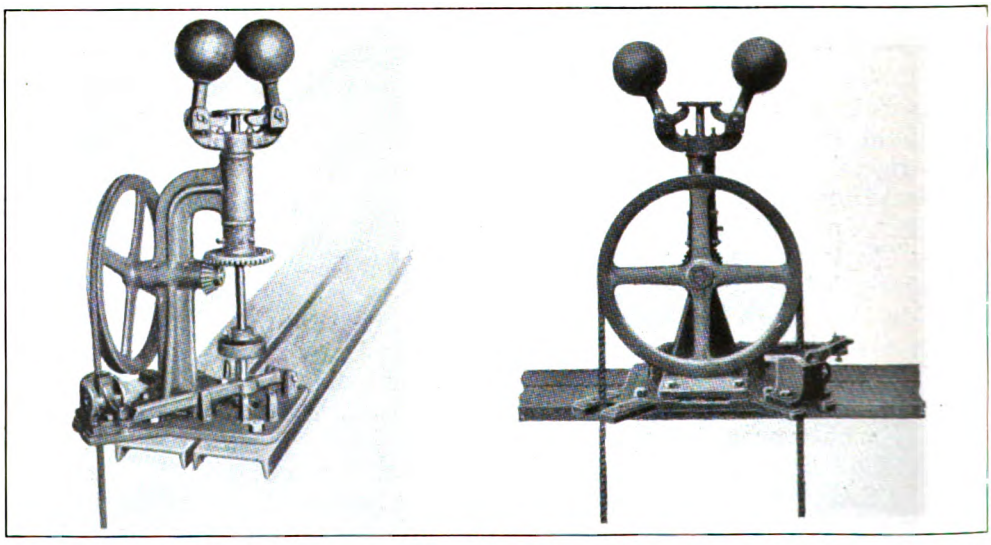

FIG. 19. GURNEY ELEVATOR GOVERNOR UNDER NORMAL CONDITIONS OF OPERATING AND WHEN IN POSITION OF ACTION CAUSED BY HIGH SPEED OF CAR

account of the loss of traction mentioned above.

None of the safety devices mentioned is brought into operation by abnormal car-speeds; thus none of them would be of value if the hoisting cables broke and let the car drop. To prevent such an accident car

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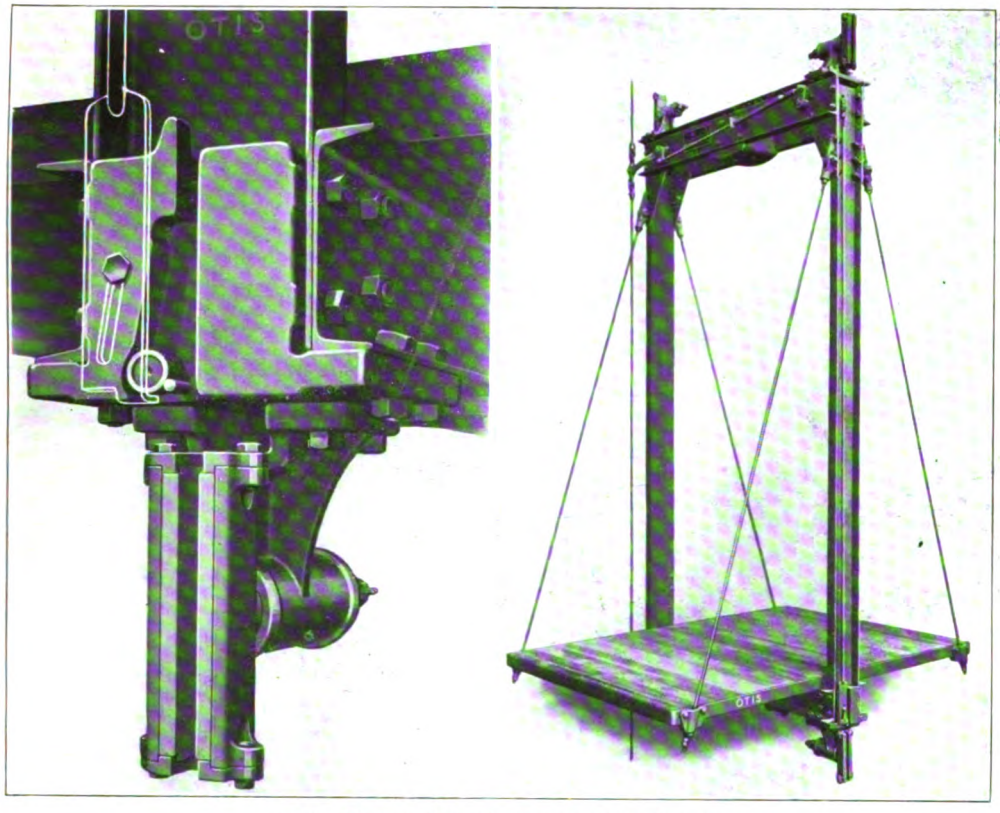

FIGS. 20 AND 21. OTIS ROLL SAFETY GRIP

At the left, detail of roll safety grip used with steel guides. At the right, roll safety grip on steel platform elevator

safety-grips are used. These grips are made to clutch the guides at the sides of the elevators with sufficient force to hold the car and prevent its descent, even if the hoisting cables are parted. Figure 17 shows the safety grip used by the Otis Elevator Company on freight elevators when the side guides are of wood. The jaws, which are shown in detail in Figure 18, are connected by means of a system of rods and levers to an endless cable which runs over a sheave at the top or bottom of the shaft. This sheave drives a centrifugal governor, which in turn is connected to a jaw clamp enclosing the endless cable. When the speed is excessive the revolving balls of the governor, Figure 19, separate, and in so doing they close the clamp which surrounds the endless cable. This stopping of the cable exerts the pull on the safety grips which causes them to engage the guide and stop the car. The square cross-shaft, part of which is shown in Figure 18, passes beneath the car floor to the grips on the other guide so that both pairs of grips, one on each side of the car, are actuated simultaneously by means of the gear teeth shown.

The type of safety grip used with steel guides is illustrated in detail in Figure 20. In this type the knurled roller is lifted by means of a finger, when the endless cable is held by the governor clutch, and is forced against the guide (not shown) by the wedge action of the inclined face of

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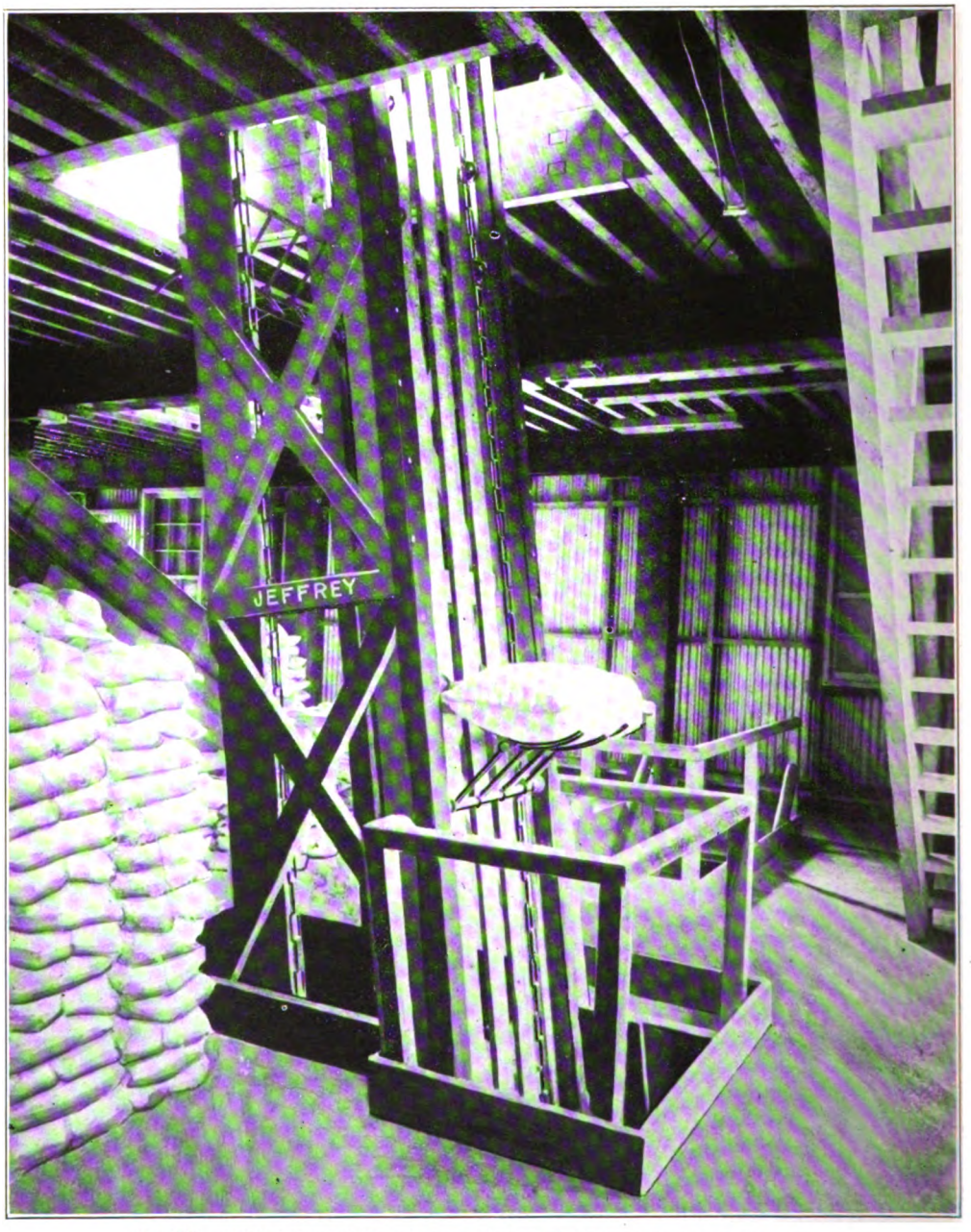

FIG. 22. JEFFREY BARREL ARM ELEVATOR HOISTING BAGS OF GRAIN

the iron block to the left of the roller. The grip on the opposite side of the car is actuated by means of a system of levers shown in Figure 21. It will be noticed that with both the grips illustrated, the force with which the cams or rolls take hold of the guides depends on the weight of the car, or, in other words, once the grips are brought in contact with the guides, the weight of the car tends to make them grip the guides with a force

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FIG. 23. CURVED FINGER TRAY ELEVATOR HOISTING BARRELS FROM FIRST TO FOURTH FLOOR
Jeffrey Manufacturing Company

which varies directly as the weight of the car.

CONTINUOUS ELEVATORS

The elevators already described may be classified as the intermittent type to distinguish them from the continuous or chain type of elevator. The bucket conveyor described in the February number of the MAGAZINE is sometimes called the bucket eleva-

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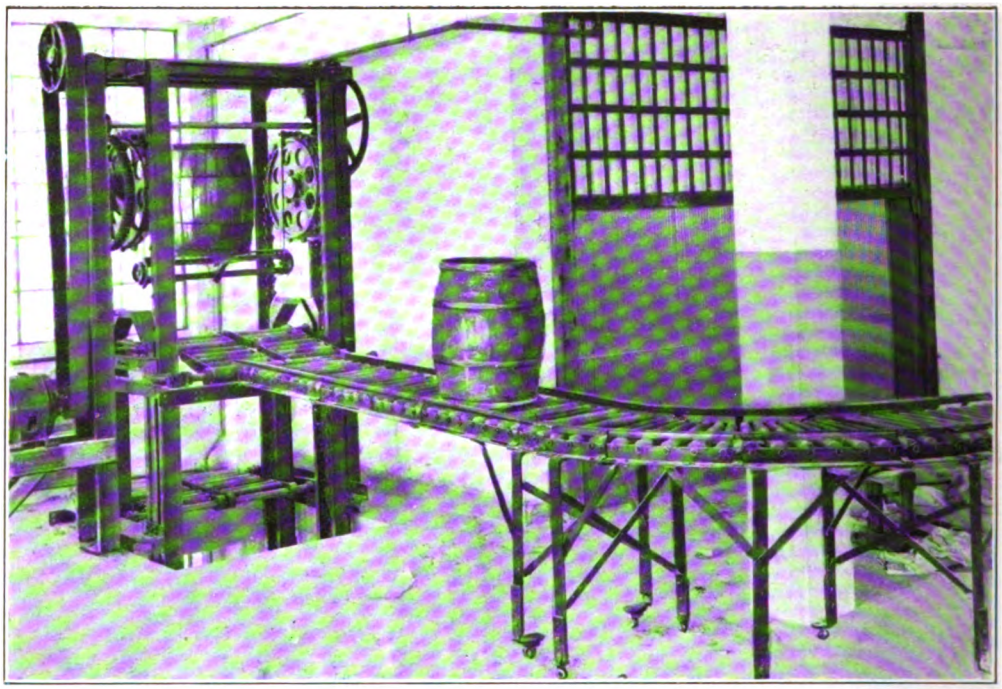

FIG. 24. ALVEY-FERGUSON VERTICAL ELEVATOR DEPOSITING ON A ROLLER GRAVITY CONVEYOR

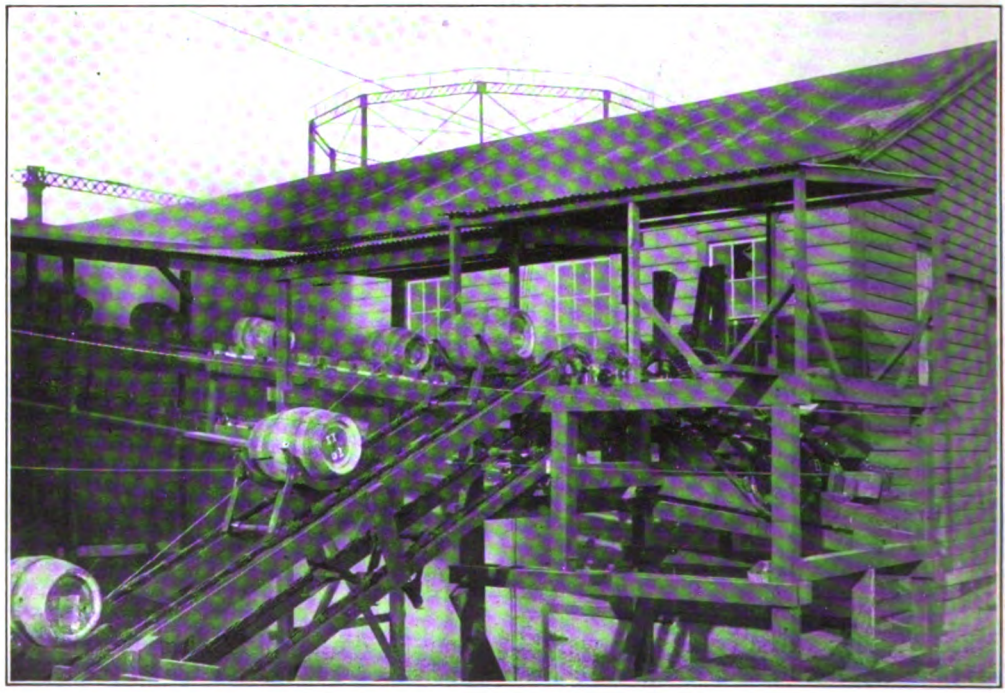

FIG. 25. JEFFREY BARREL ARM ELEVATOR DEPOSITING ON TRANSVERSE APRON ELEVATOR

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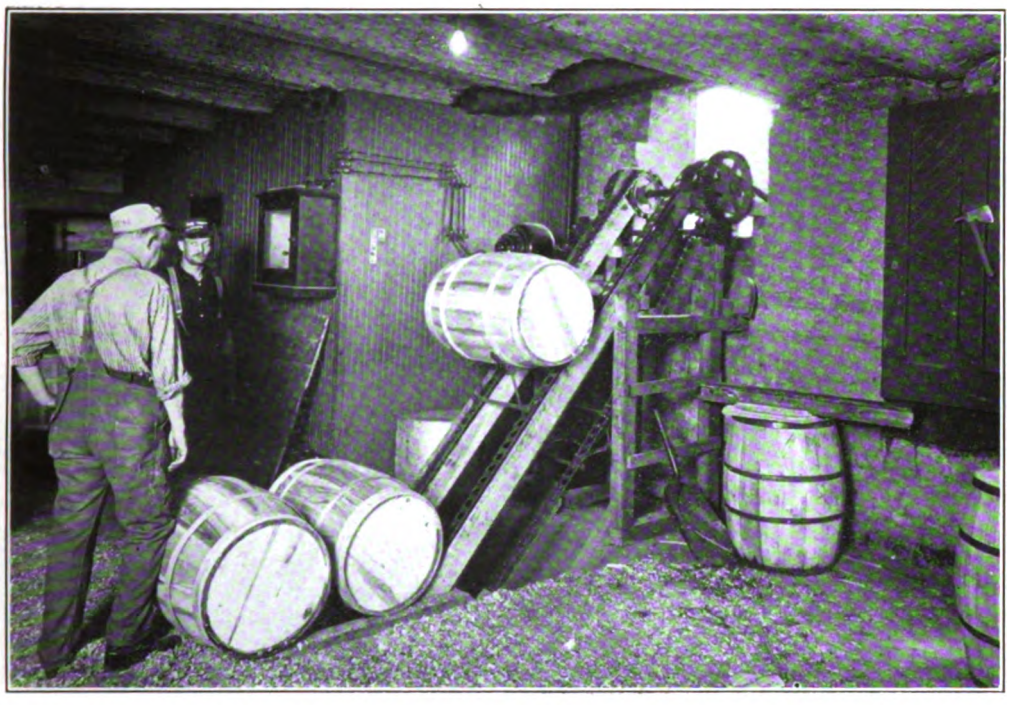

FIG. 26. JEFFREY BARREL ARM ELEVATOR HOISTING BARRELS FROM BASEMENT TO LOADING PLATFORM

tor, but on account of its being used also as a horizontal carrier and on account of its close alliance with other forms of conveyors, the writer thought it well to include the bucket type with the other conveyors. There is another class of machine, however, that is similar to conveyors in that it is usually built up of endless chains as the main moving part. These are elevators in the sense that they are used for conveying material from one level to another and often in a vertical direction. Many of them, however, are not vertical and are known as inclined elevators.

The continuous elevators may be divided into two classes, the permanent or fixed, and the portable. The permanent elevators are usually built to perform one distinct operation, that is, to carry packages of one general form. Thus, a barrel elevator would not be suitable for handling boxes, and one that was built for handling bags of wool would hardly be suitable for hoisting kegs of nails. For this reason we hardly expect to find these machines highly standardized and made in stock sizes, and the fact is that each installation usually requires some special design and differs essentially from almost every other installation. The same can hardly be said of the portable elevator, however. They may be and are standardized to a certain extent and are built up in some stock sizes, which differ only in the form of the carrier put on the chains.

The permanent continuous elevator is usually made up of standard parts fitted together to conform to the requirements of the particular work the elevator is to do. In Figure 22 is shown a Jeffrey barrel arm-conveyor used for hoisting bags of grain. The arms are of such shape that

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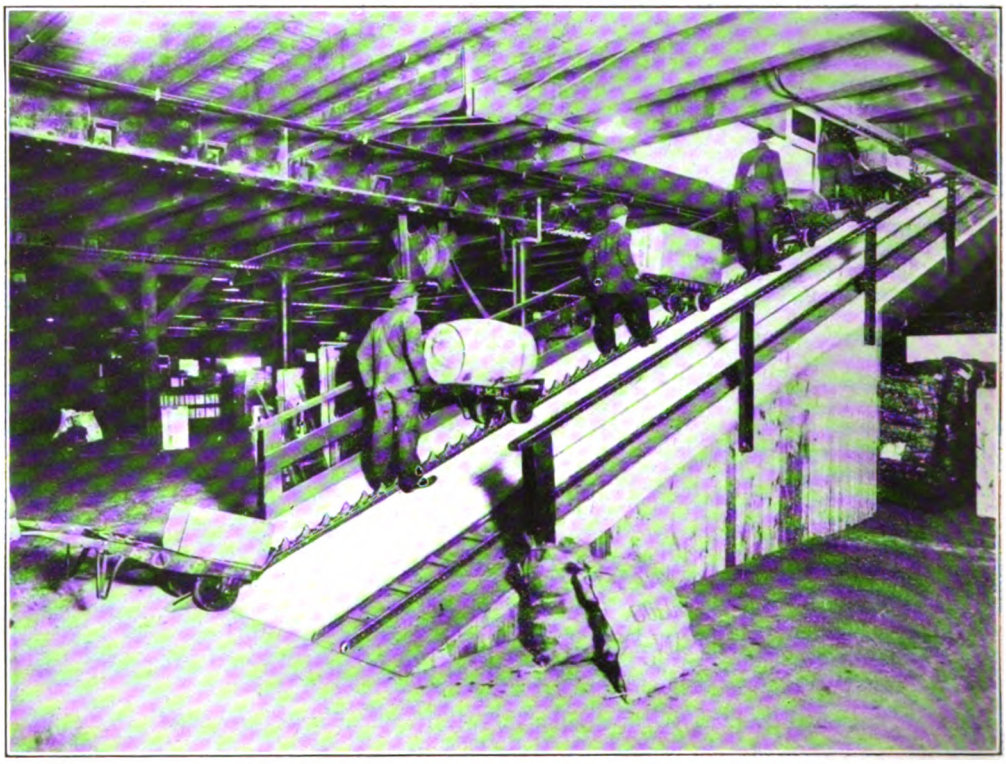

FIG. 27. OTIS INCLINED ELEVATOR IN THE FREIGHT HOUSE OF THE PERE MARQUETTE R. R., THIRD AND CONGRESS STREETS, DETROIT, MICHIGAN

either bags or barrels may be carried but boxes could not be handled conviently. The carrying arms are mounted on cross-rods and rollers, which are fitted to flat and round steel-link chains. A similar machine, but with fingers of a different shape, is shown in Figure 23. This machine is used for hoisting barrels from the first to the fourth floor.

In Figure 24 is shown an Alvey-Ferguson vertical elevator, hoisting barrels and depositing them on a roller gravity conveyor. The elevator, which is driven by an electric motor through a belt and two pairs of spur gears, consists of trays suspended from flat-bar and roller chains by means of straps. The tray is carried over the sprocket as shown and on the down side the barrel or box, as the case may be, is deposited on the gravity conveyor as the tray passes between the rollers.

Figure 25 shows a unique installation in which two types of conveyors are used. The one in the foreground has barrel arms made of steel and attached to flat-bar chains. This elevator carries kegs which are deposited on the transverse elevator shown in the background. In order to prevent turning each keg through 90 degrees as it goes from one elevator to another, a pan conveyor is used which receives the kegs as they come from the arm elevator. Both elevators are driven from the same motor by means of bevel gears.

It is not necessary that the distance be great in order to make the installation of a continuous elevator a good investment. The question of installing such a machine depends on both

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FIG. 28. SAME TYPE OF ELEVATOR SHOWN IN FIG. 27, HOISTING DUMP CARS UP AN INCLINE AT FOX FURNACE COMPANY, ELYRIA, OHIO

the distance and the number of packages to be handled in a given time. Figure 26 illustrates a short barrel-elevator used for lifting barrels from a basement to a loading platform, the vertical distance being about six feet. The chains are made up of standard malleable-iron link belts to which are attached the curved arms for carrying the barrels. This same type may be used for handling pipe, logs, rolls of carpet, etc., by employing two or more chains spaced farther apart.

There is a type of machine called "inclined elevator" that is used for helping trucks or cars up grades that are too steep for the power used on levels. This type is frequently installed on docks to assist stevedores with loaded trucks, or in industrial plants to help truckmen or industrial cars from one level to another. Three applications of the Otis inclined elevator are shown in Figures 27, 28, and 29. The endless chain is made with projecting teeth, which move in a steel channel and over sprockets at each end. The truck or car is pushed

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FIG. 29. OTIS INCLINED ELEVATOR ASSISTING TRUCKMEN UP AN INCLINE AT THE PLANT OF THE CONTINENTAL PAPER COMPANY, BOGOTA, NEW JERSEY

over the bottom sprocket, its axle is engaged by a tooth, and the load pushed along while its weight is still carried on the truck wheels. The chain is usually made reversible and is designed to operate at two speeds, the most satisfactory being 125 and 250 feet per minute.

The portable elevator may be used to good advantage in the warehouse, stock room, or shipping department to pile and tier packages of any size, weight or form. The machine is self-contained and mounted on wheels so that it may be moved easily from one position to another. This leaves the maximum floor space available for storage purposes. The portable ele-

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FIG. 30. "BROWN PORTABLE" STANDARD ELEVATOR USED FOR PILING HAY

Machines of this class are made to pile to a height of 30 feet, with a capacity of a ton a minute

vators or pilers illustrated in Figures 30 to 33 are built by the Brown Portable Elevator Company of Chicago. While these particular machines are especially adapted to piling and tiering, the same company builds machines along similar lines for conveying and unloading, as well as combination machines which will convey material for any reasonable distance,

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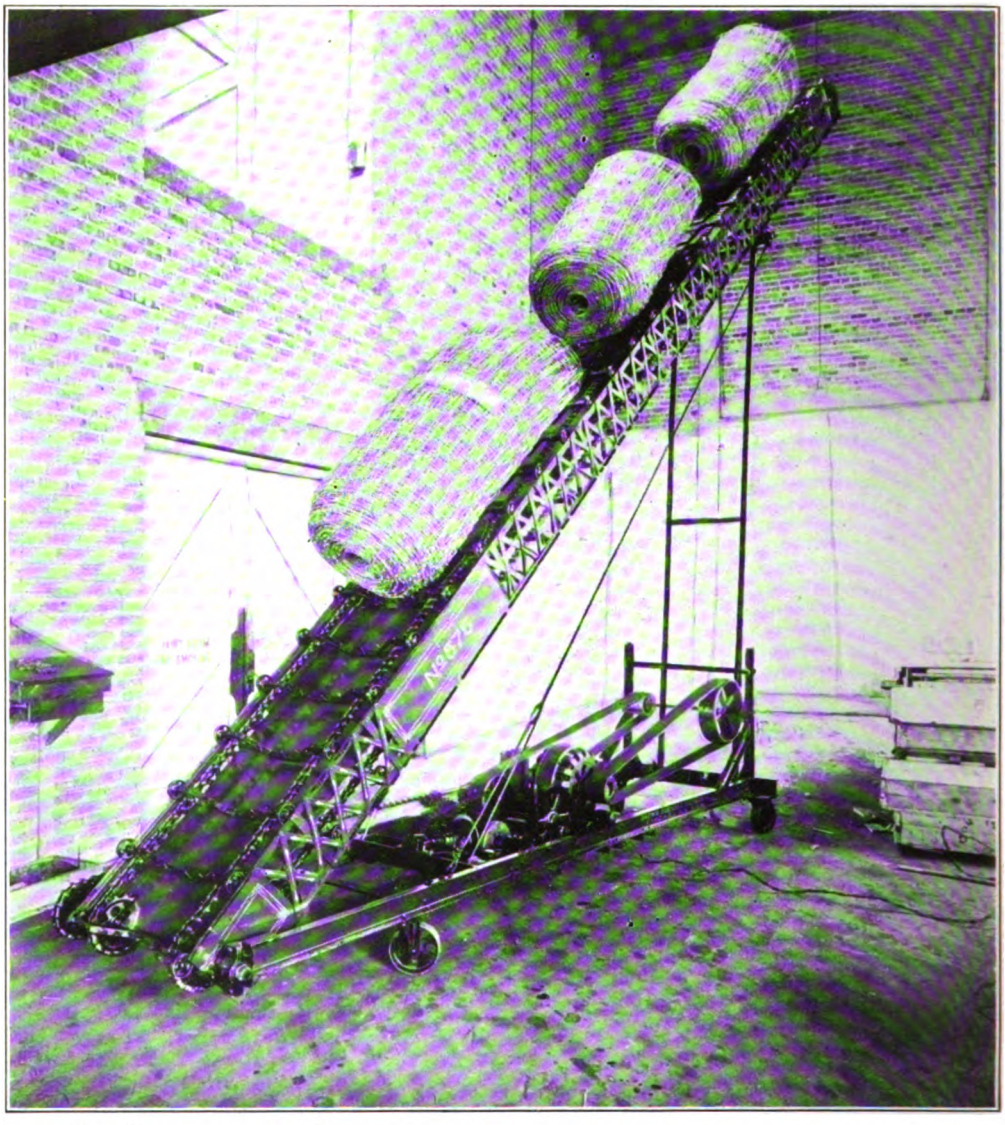

FIG. 31. "BROWN-PORTABLE" PILER EQUIPPED WITH DROP AXLES FOR HANDLING HEAVY ROLLS, BARRELS, ETC.

In this particular case the machine is handling three rolls of wire fence per minute, each roll weighing 650 pounds. It displaced 12 men and did the work in one-third the time required by them

depending on the number of portable sections used, and then elevate it for piling.

The piling and tiering machines used consist of a wood or steel frame, an adjustable carrier of steel truss work, and an endless conveyor with its driving machinery, the whole mounted on ball bearing casters. The carrier is pivoted to the frame at its lower end, the upper end being supported and adjusted by an upright frame of iron pipe or structural steel. This is connected by a steel cable on each side of the frame to a raising device mounted on the frame, by

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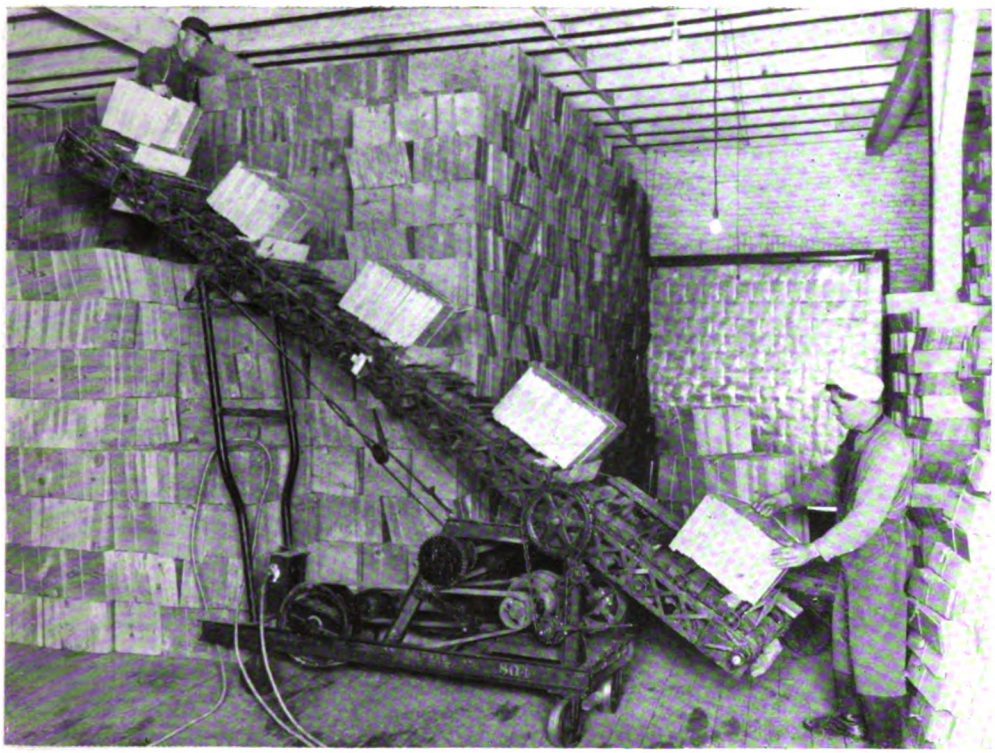

FIG. 32. "BROWN PORTABLE" ELEVATOR WITH SPECIAL CONVEYOR FOR BUNDLES OF "SHOOKS"

FIG. 33. THREE "BROWN-PORTABLE" PILERS IN SUGAR WAREHOUSE

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which the carrier is raised as the pile increases in height. On smaller machines the raising device consists of a hand crank with reducing gears and ratchets, while on large and heavy machines it consists of a worm gear and friction wheels actuated by the motive power of the machine.

The conveyor consists of two endless chains passing over sprockets at the ends of the carrier. Connecting these chains are cross-bars which carry rollers. These rollers run on steel tracks to reduce the friction. The driving unit is mounted on the frame. Where electricity is available it is the most convenient power to use, the field of operation of any one machine being limited only by the length of the power cable and the number of plug-in stations. Where electricity is not available, gasoline engines may be used to good advantage.

To be continued

STRIPPING THE OVERBURDEN IN OPENPIT MINING

By L. O. Kellogg

Few realize how important in American mining, openpit operations with steam shovels have become. The development of this method constitutes one of the greatest advances in the technical practice of the industry. The economy of openpit work hinges largely on the cost of removing the worthless overlying material. The past few years have witnessed the introduction of some new methods to this operation, which Mr. Kellogg here reviews.—THE EDITORS.

THE term "mine" to those who have some, but not too much, knowledge of mining, signifies a network of underground passages, of little hallways and stairways and big chimneys through the rock, connecting great chambers; the entire system entered by means of one or more long holes at any inclination up to vertical, that is, by adits, inclines, or vertical shafts. Such indeed is an underground mine; and the underground method of extracting ore is still the most important. Yet in 1913, something over twenty-five per cent of the ore produced in the United States, omitting placers, was mined out under the open sky, and if any underground workings were connected with the properties from which this tonnage came, they were either old and abandoned or were wholly incidental to the mining operations. We may take ore to mean the solid mineral substances from which metal was subsequently extracted, and thus exclude quarries from consideration, although in this country quarrying is rarely an underground undertaking.

This openpit mining, which is the best general designation for operations not carried on underground, is especially a feature of American practice, and in its perfected form is a development of the last twenty-five years, more or less. Extraction of ore from open workings has probably been practiced as long as has mining itself. It seems probable that the openpit was earlier than the underground mine, since it is obviously simpler and easier to break material off at the surface than to burrow into the earth for it. Mill holes, glory holes, trenches, opencuts are element-

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TAKING THE FIRST CUT

The very beginning of stripping the Wakefield orebody near Ironwood, Michigan. The shovel is encountering difficult conditions of wet swampy ground and interfering stumps of trees. The stripping cars are about to be run up to the shovel on the undulating track at the left

ary, and often preliminary, openings for the extraction of mineral wealth, and frequently are operated along with more important underground workings. But the figures given were intended to cover only the tonnage produced from fully developed openpits in which the ore is loaded with a steam shovel direct into railroad cars and hauled out of the pit by a locomotive.

The true openpit is inseparable from the steam shovel. This heavyweight "mucker" is the right-hand machine of the openpit miner, his pride and his pet, just as the underground miner claims for his own the compressed-air rock drill. It is a matter of curious comparison that the operation of loading or mucking, the getting of the broken ore into the cars, reached its highest development in the openpits, and the operation of breaking the ore, the drilling and blasting, has been brought to a high state of excellence underground, whereas drilling practice in the openpits in many cases lags sadly and underground mucking has not notably changed in three or four thousand years.

The steam shovel is the most efficient "mucker" known. Although not invented by the miner, it was early adopted by him, and it has been brought to its present degree of efficiency chiefly through the efforts of the iron miner. Joseph Sellwood first used it in Michigan in 1887, to load stockpiles of winter-hoisted ore into railroad cars for shipping. Then, when John Jones, by opening up the Biwabik mine, started the Mesabi range on its career, he made a daring experiment and put in a steam shovel to handle the great quantities of material he had to strip. From the start the machine proved to be worth its keep. But no steam shovel had ever before been against such service as this; at first it was necessary to have two machines on hand in order to insure that one would be always in the pit working. As the weak points developed, however, they were strengthened, and gradually trips to the shop became so infrequent that it was possible to keep two out of three shovels always on the job. Then, finally, design became so nearly perfected that a shovel could be depended upon to work a whole summer season without serious delays for repairs. This was a slow development, using cut-and-try methods, but it was effective and resulted in a fast, rugged, reliable, digging machine, found ready to hand when we tackled the job of cutting the Isthmus. Many elements in that spectacular problem had been solved

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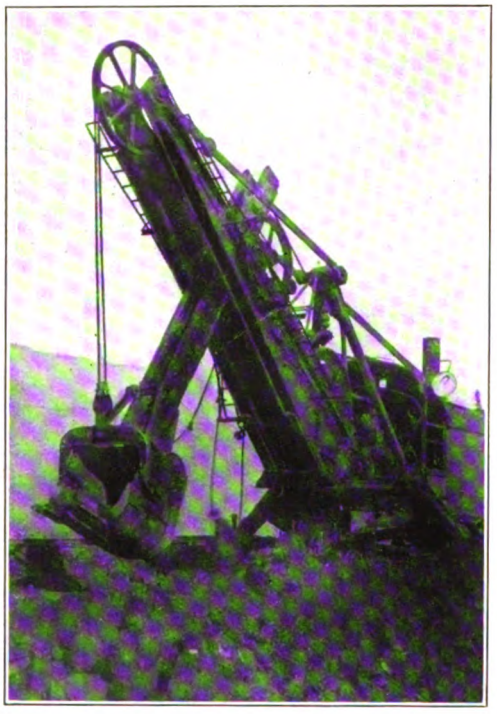

AN ATLANTIC SHOVEL "BOW-ON"

In use in the Leonard pit near Chisholm on the Mesabi range

years before on the Mesabi iron range.

The typical Mesabi shovel weighs from 90 to 120 tons; it is of Bucyrus or Marion make, and is nonrevolving, that is to say, the body of the shovel remains stationary while the boom swings on the front; also it has a chain hoist. A few Atlantic cable-hoist machines are in use and seem to be successful. They differ in having no block on the dipper bail and in mounting the hoisting engine on the bottom of the boom. A good many advantages are claimed for them, but they have not displaced their rivals.

The process of strengthening and improving is still going on, although it would seem that the ultimate is so nearly reached in this particular type of excavator that progress now is slow and changes are all made in minor points of design. The tendency is to build the shovels continually heavier without particularly increasing their capacity. The resulting freedom from breakdown and the longer life more than compensate for the extra weight and the greater cost of construction.

Our greatest mines today are steam shovel mines. In the country around Lake Superior, especially on the Mesabi range, and in the copper areas of the Southwest, properties have been developed which surpass both in tonnage of ore mined per day and in the magnitude of their reserves the wildest dreams of old-time operators. The greatest of these, the king of all mines, is Utah Copper, which ships 8,500,000 tons yearly and, according to its latest annual report, had on hand a 342,500,000-ton mountain of profitable copper ore. On the Mesabi, probably as great tonnages per day have been mined, but the shorter season there cuts down the annual tonnage and the reserves developed in any one property are in general much smaller.

The bulk of the openpit tonnage is put out by the Jackling string of copper porphyries, Utah Copper, Nevada Consolidated, and Chino; and by the Mesabi mines of which the Oliver Mining Co., subsidiary of the Steel Corporation, owns and operates more than any other one concern.

There are openpits on the Cuyuna range and two in the Michigan iron country; others are scattered over the United States, several in New York, smaller for the most part. In the Black Hills of South Dakota, a remarkable achievement in low-cost operation is that of the Wasp No. 2 gold mine, where a steam shovel loads up the rather moderate daily tonnage. Other miscellaneous mines have used or are using steam shovels, and we are taking no account of the multitude of quarries and nonmetallic mines such

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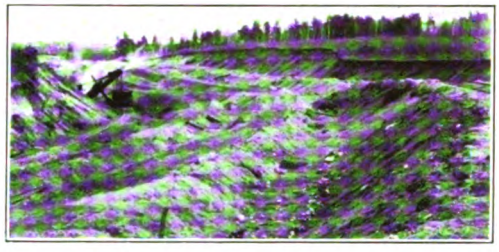
as those of phosphate rock. Coal mines also are outside our category, although some noteworthy operations in stripping coal land are being carried on in the Middle West and will be further described in this article.

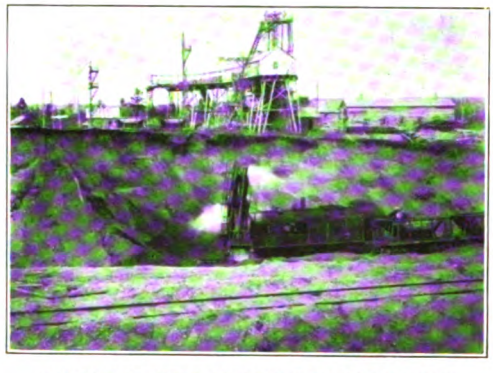
The economies of openpit work are many. Its vast scale, involving wholesale methods of breaking and handling the ore, is of prime importance; the elimination of the ever more expensive timber needed by most underground mines and avoidance of rehandling the ore are also important factors; but the outstanding feature is the capacity and economy of the steam shovel.

An idea of what the economy of openpit mining means may be had from some approximate unit costs from some different classes of mines. Down in South Africa on the Witwatersrand is the second greatest mining district in the world. Here an inclined layer of hard medium-grade gold ore is mined at great depth, largely by native negro labor. Although the mines are of great size, the average production rate is only about two-thirds of a ton per man per day.

In America, it used to be the aim of the manager of a small narrow-vein western mine not to drop below a ton per man per day and to do as much better as possible. A medium-sized gold mine, such as the Hollinger, in Ontario, probably gets today about two tons. In the Treadwell group on Douglas Island, Alaska, where the lode is wide, the figure is about 5½ tons. The British Columbia Copper Co., at one of its mines, breaks its ore in a wholesale manner underground and gets 11 tons. While for the Utah Copper Co., in 1912, the production of the mine per man per day figured to about the same basis was about 15 tons. This is the greatest success attending the constant effort of the mine manager to reduce the labor item on his cost-sheet.



STRIPPING THE THOMPSON PIT
This was the third Cuyuna deposit to be stripped for mining. It is a long, narrow cut



ANOTHER VIEW OF THE THOMPSON PIT
Note the shaft on the side. The mine was first opened as an underground operation and it was later decided to strip part of it. Underground operations frequently precede, accompany, or follow openpit mining on the same orebody and even where no underground mining is carried on a shaft on the side of the pit may be used for pumping purposes

An openpit is almost as truly a railroad as it is a mine; it is not infrequently organized on a railroad basis. It maintains an equipment of cars and locomotives beside its shovels, has several miles of track, and includes in its plant a roundhouse and a machine shop. Curves, grades, and banks are all carefully calculated. The laying out of the pit and its operation is often an engineering feat of consequence, especially in view of the fact that the grade of the ore mined must be maintained and must be capable of variation as occasion demands.

Almost all of these ore deposits that are mined as openpits are covered with a layer of valueless material;

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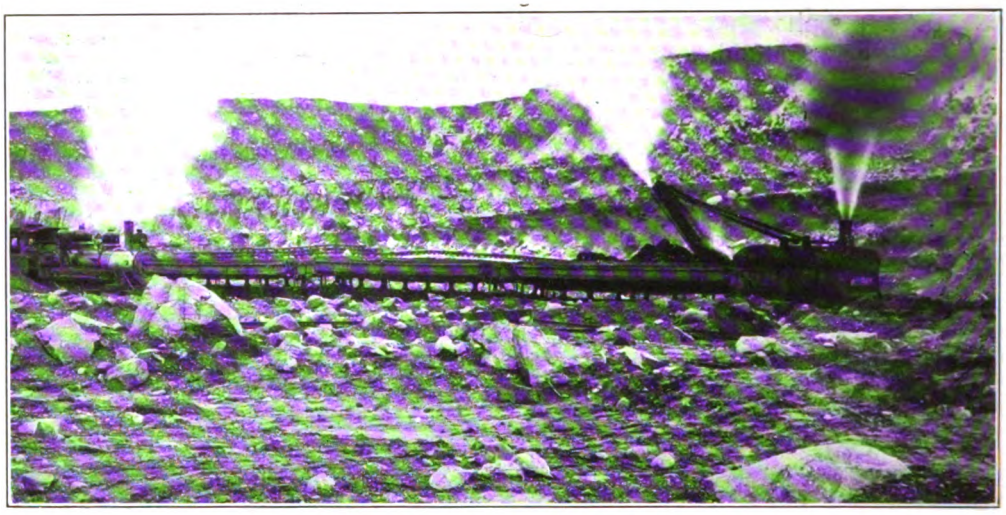

A LARGE STRIPPING JOB ON THE MESABI

The Longyear pit near Hibbing, originally mined by underground methods took several years to prepare for openpit operations. The stripping cars shown in process of loading hold 20 cubic yards, are equipped with air-brakes, and are dumped by compressed-air mechanism

overburden, or capping, it is called. The only prominent exception is a copper deposit in the Ajo Mountains of Arizona, which outcrops at the surface and from which no waste will have to be removed for some time after mining operations start. In all other cases the overburden, which may be glacial drift or rock, has to be taken off before mining can begin, and this may cost as much as mining the ore itself, in some cases even more. Its thickness in relation to the thickness of the ore is the greatest single factor in determining whether an ore deposits can be worked by the openpit system or whether underground methods will have to be resorted to. It is commonly considered on the Mesabi that it does not pay to strip more than one cubic yard of overburden per ton of ore to be mined, or to remove more than two feet in depth of overburden for one foot of ore, or to strip off more than 150 feet depth of overburden under any circumstances; rock in such calculations being taken as equivalent to three times as much as drift material. In general, however, it may be said that the tendency today is strongly toward openpit operations as against underground. Old underground mines are being made over into openpits and deeper and deeper pits are being dug. The field of openpit methods is constantly extending.

Stripping off the overburden is the first great problem that confronts the openpit miner. Stripping is essentially a mining job and involves the same methods as those used in mining the ore. Sometimes it is easier, frequently it is much harder. In stripping, as in actual mining, the steam shovel is the operator's main reliance, and on the Mesabi range, stripping is the very hardest work the shovel has to do. Boulders and rock in place and in winter frozen material do their best to wreck the shovel or wear it out.

The stripping of a pit as well as the subsequent mining requires an approach, which usually consists of a cut of suitable grade more or less straight. When this enters the pit, the descent to the bottom is continued

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LOADING ORE AT THE ONTARIO IRON MINE IN NEW YORK
Here a relatively great thickness of overburden is removed to get at a thin layer of hematite ore

by means of curves around the sides or by switchbacks, preferably curves. A deep and not so very extensive pit without switchbacks, such as the Shenango or the Commodore on the Mesabi, resembles nothing so much as Dante's description of the nether world, with its descending and contracting circular benches on which the tracks are laid.

The disposal of the spoil from stripping is a problem of importance. Indeed the possibility of stripping may depend on the proximity of available dumping ground. It is important that the material be not dumped on ground over an orebody that may subsequently be mined; and along the Mesabi, orebodies are as thick as fleas. There, also, large areas of useless land are covered with a swamp growth called muskeg, which under weight acts like a bedspring and is therefore unavailable for the stripping dump.

A stripping dump usually is started from a trestle which is built along as it is filled below and on both sides, until the limit of the area to be covered is reached. The trestles are built as light as possible, and the train always backs out, so that only empty cars are carried by the bents which are still unsupported by fill. When the trestle is extended the length of the dumping ground, the tracks are thrown to the sides on the fill already made and the dump is thus fanned out. Successive layers are built up until the dump reaches a height that involves prohibitive grades.

Some remarkable achievements in stripping-dump construction are recorded. The Commodore is a relatively small pit, but deep; it covers about the half of a 40-acre tract. The deposit was first mined by underground methods. When it was later decided to strip it, dump room was scarce in the vicinity. It was found necessary to dispose of about half the spoil on the same 40-acre tract that contained the mine. Shay-type geared locomotives were adopted and

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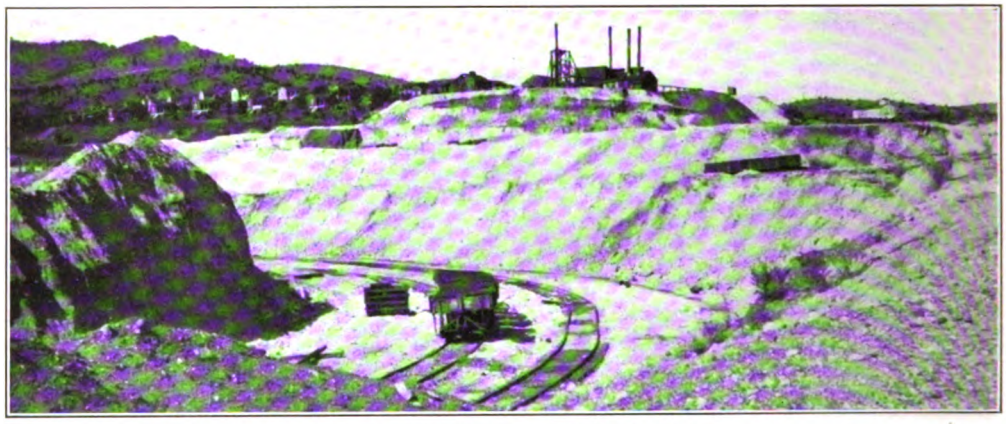

PART OF THE CHINO COPPER OPENPIT

sharp curves and steep grades were thus made possible. The dump was built up alongside the pit with only a few feet of one switchback extending off the 40 acres. The maximum difference in elevation at the completion of stripping was about 250 feet. Consider overcoming a difference of elevation of 250 feet confined to a square with quarter-mile sides and hampered by countless other conditions! At present the difference in elevation is about 300 feet, and the sides of the dump and the pit being almost flush, there is presented an artificial precipice most impressive.

The magnitude of stripping operations is forcibly impressed on the visitor to the Mesabi. More remarkable even than the smoke-filled red pits themselves, or the fine network of tracks covering the countryside, are the great piles of stripped material limiting the horizon on every hand, resembling in shape, color and even magnitude a series of Southwestern mesas, too huge apparently to be the result of anything but geologic processes.

For Mesabi stripping a great variety of equipment is used. It is generally designated either as "standard" or as "dinky." Standard equipment comprises heavy rails laid to standard gage, standard locomotives, heavy shovels, and contractors' side-dump cars ranging in capacity even up to 20 and 24 cubic yards; the larger cars, equipped as they are with air brakes and air-cylinder dumping devices, are becoming increasingly popular. The dinky equipment implies narrow-gage track, smaller locomotives, from 14 to 26 tons, and smaller cars holding often not more than three or four cubic yards. The Shay type of locomotive offers economies under certain difficult conditions.

Some overburden needs blasting, some can be handled by the shovel direct. In general, the Southwestern copper cappings have to be blasted and for this work churn drills are chiefly used. Large holes are put down with these machines, their bottoms enlarged by exploding dynamite and the enlarged chamber filled with black powder or other low explosives for the final blasting. Sometimes, instead of drilling, small tunnels are excavated in the bottom of the bench and a mammoth blast set off therein. These are called "gopher" holes. On the Mesabi range, however, gopher holes are flatly inclined holes into the bottom of a bank, worked out by long hand tools; they are twenty feet or so in depth, and in diameter somewhat

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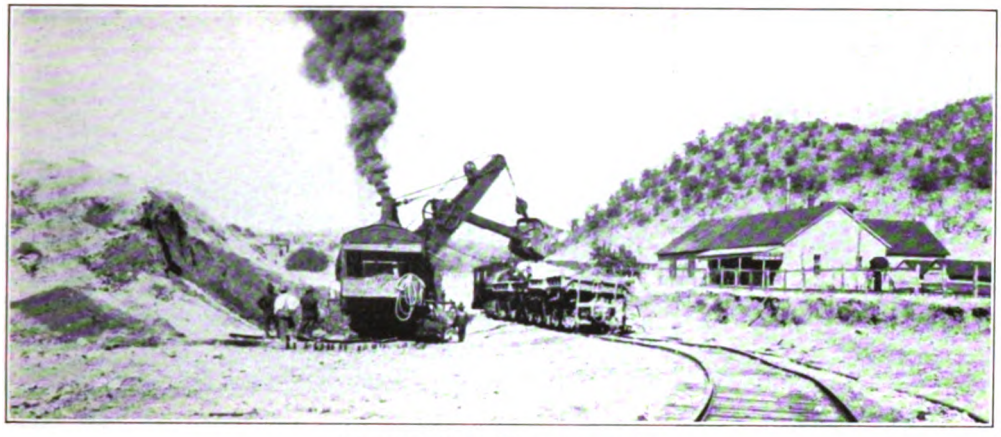

LOADING OPERATION AT CHINO

larger than a woodchuck hole. The alternative to these in the iron country are vertical holes put in a few feet back from the edge of the bench, about like a churn-drill hole, the work, however, done by hand or with a piston rock drill. In hand work, a group of men work up and down a long and heavy jumper bar having a chisel point on each end. A heavy piston drill mounted on a tripod is required when the rock is hard. A large part of the Mesabi overburden, being unconsolidated glacial drift, requires no blasting, except that boulders too large for the shovel dipper require breaking up.

The shipping season on the iron ranges is a short one, covering only about seven months; the openpit mining season corresponds to this. Naturally the companies like to turn their men and equipment to stripping work when winter sets in, supposing that the stripping is not done on contract. This is economical, but winter stripping is about the hardest service the shovel has to stand. Digging into frozen or partly frozen ground puts stresses into the whole machine comparable only with work in heavy boulders or poorly broken rock.

Admirable as the steam shovel is as an excavator, its use in stripping leaves something to be desired. The continual shifting of tracks, the need of keeping the grades low for locomotive haulage even when geared engines are used, the necessity of the shovel's being at the bottom of the bank and working up, the fact that the return of the empty trains does not compensate for the dead weight hauled out, are all deficiencies repugnant to the progressive engineer. Consequently, many attempts have been made to beat the steam shovel, but with no success until a few years ago. More innovations in stripping methods on the iron ranges have been seen in the past three years than in any previous decade, and at least three of these were attended with a considerable measure of success.

One of the early attempts at improving on the steam shovel involved the use of a cableway, operating along the sides of the pit, and a grab bucket. This looked like a plausible method, but it proved unsuccessful. Capacity, it is understood, was lacking. Stripping is a slow job at best, and involves the tying up of a great deal of capital, both in the cost of the work itself and in the deferred returns on the ore. Consequently, speed is a great desideratum in order to cut down interest charges.

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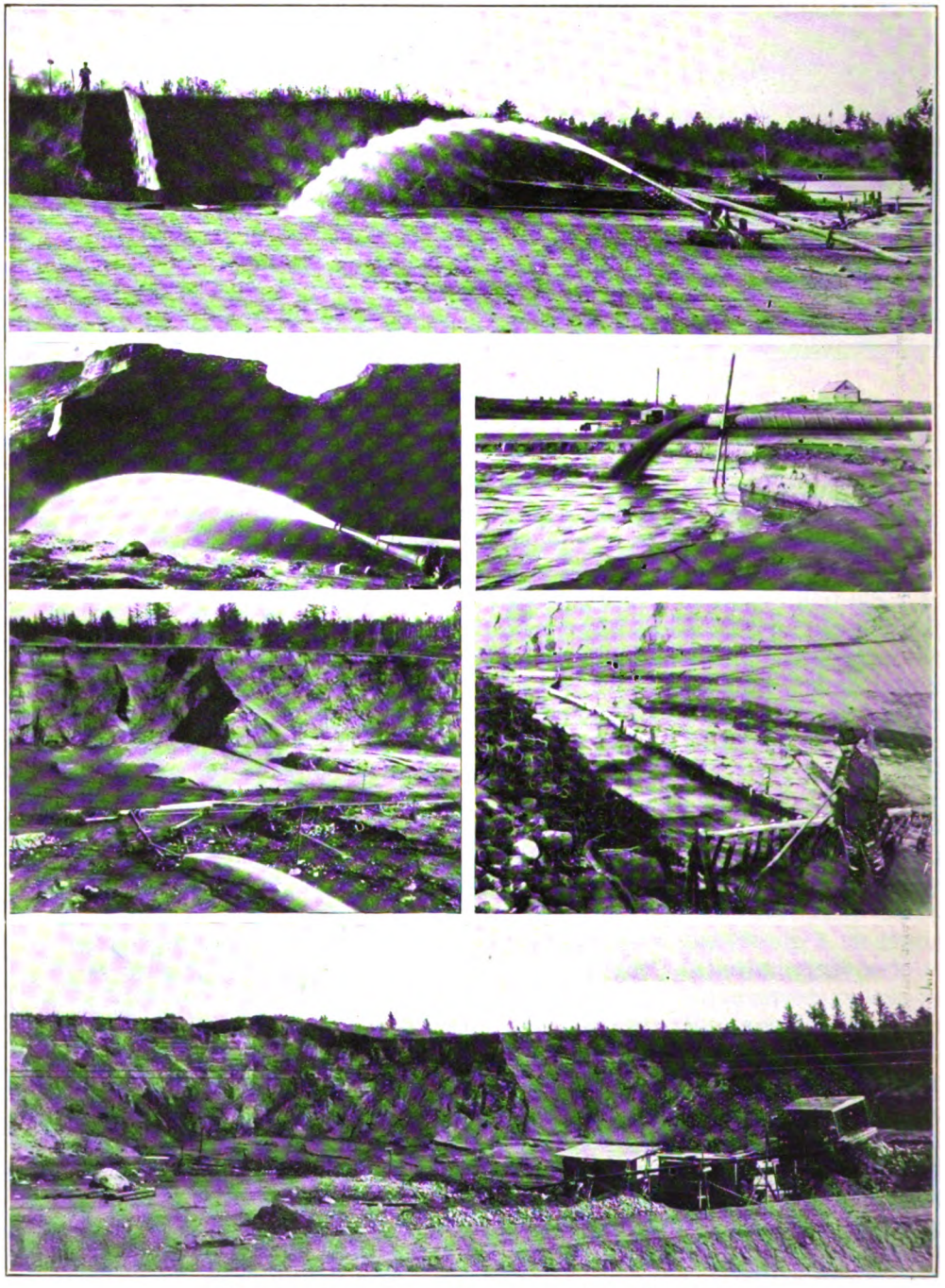

HYDRAULICKING THE SURFACE OFF THE ROWE MINE

Beginning of operations

Giant working against bank — Discharge from sand pump

Ore showing in pit bottom — Sluiceway and rack

Advanced stage in operations

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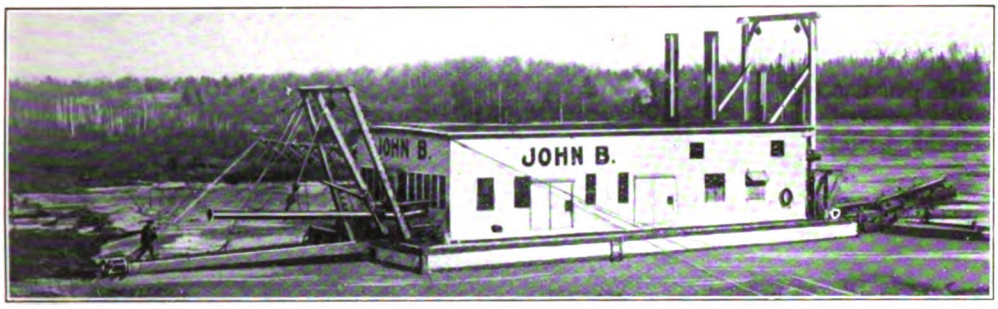

THE UNSUCCESSFUL JONES & LAUGHLIN DREDGE

The boat is just starting to eat her way in from the Mississippi River which shows at the right. The dam was to be built about where the stern of the boat lies now

In the summer of 1913, the Pittsburgh Steel Ore Co. decided to try hydraulic methods for getting rid of the glacial drift over its deposits of iron ore on the Cuyuna range, the Rowe mine. The scheme was a great success. While steam shovels were called in to help complete the work within the time set, the costs attained by the hydraulic method were astonishingly low and the necessary capacity and speed could have been obtained by an increase in plant. The governing conditions were, however, almost ideal. The deposit was on the edge of a body of water into which the material could be sluiced as removed. The overburden was chiefly fine sand; large boulders were rare, and there was no rock formation to be removed.

The installation in its final form consisted of a pair of electrically driven pressure pumps set on the edge of the body of water mentioned and picking up water therefrom. This was delivered under pressure through a spiral-riveted pipe-line to the nozzle of a hydraulic giant working in the pit. The method is essentially that used by the hydraulic gold-placer miners, and that followed by Seattle in leveling her obstreperous hills. Hydraulic methods also have been used for some time in the Florida phosphate fields.

The overburden on the side of the pit was cut out by the stream from the giant and washed down to the low point on the surface of the underlying iron ore, which formed the floor of the pit. At this low point a sump was constructed, and an electrically-driven centrifugal sand pump picked up the debris and water from the sump and hoisted it through another spiral-riveted pipe-line over the edge of the pit to its discharge on the water's edge. The top of the ore was about fifty feet below the water level, with an impervious clay bank between.

This operation attracted a great deal of attention and was followed by a similar operation at the Hillcrest mine on the same range. It also probably suggested to the Jones & Laughlin Co. to try another hydraulic method on a property which it held under option at the tip end of the Mesabi range to the west. The deposit was a large one but extremely low grade; too low-grade, it was believed, to yield a profit even with steam-shovel stripping. It was deemed necessary to devise some cheaper method, and the company therefore experimented with a small harbor dredge shown in the illustration.

This was designed and built especially for the work. The suction pipe under the cutter head was connected

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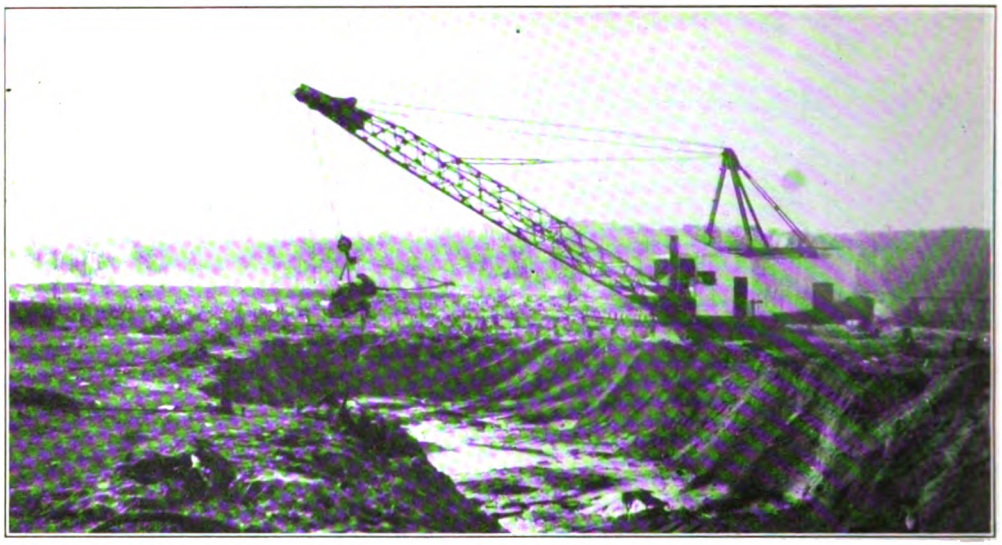

BUCYRUS DRAGLINE EXCAVATOR STRIPPING THE BALKAN PIT

The bucket has just taken its load. Note the water in the bottom of the cut

to one centrifugal pump on the boat. A duplicate pump was connected to another suction pipe for operation in material which did not need cutting; finally a small hydraulic giant was mounted on the bow to work against the bank, as soon as one was established, and wash it down to the second suction pipe described. Although the orebody lay adjacent to the Mississippi River and the dredge started working in from the river itself, the debris could not be disposed of in the river but had to be pumped a considerable distance through a pipe line. It was the intention to build a dam across the channel cut from the river and admit only enough water to flood the dredge and transport the debris through the pipes.

Although the boat held out promise of success at first, it was eventually abandoned after only a little work was done. The chief difficulty lay in the character of the overburden. Trouble was had with clay and snags, and the boulders encountered made it almost impossible to operate the dredge. It is not unlikely that under the favorable conditions which the Pittsburgh Steel Ore encountered on the Cuyuna the dredge would have been successful. The water could have been made to carry a heavier burden, and the ease of moving the self-contained plant would have proved most convenient. Speaking broadly, the degree of success attained by these hydraulic methods was most encouraging and indicates that for some classes of work the steam shovel can be beaten.

Two ore deposits were recently found in Michigan that were available for stripping; so far no steam-shovel openpit of importance had been operated in that state. One of these is the Wakefield mine near Ironwood; the other, the Balkan near Crystal Falls. For stripping the Balkan, a machine new to the purpose was used, the drag-line excavator. While the shape, size, and depth of this deposit suggested stripping, it was unfortunately largely overlain by swampy ground. Several stripping contractors looked the job over and shook their heads. Then the mining

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BUCYRUS DRAGLINE EXCAVATOR STRIPPING THE BALKAN PIT
The bucket is discharging into a loading hopper set over the track on which the small dump cars run

company diverted a stream of water, did some drainage, and agreed to keep the ground drained for the contractor, and one of the more venturesome, Winston Bros., decided to tackle it. But scepticism in regard to the behavior of steam shovels in the quicksand of the swamp led the contractors to try dragline machines. This was the first time they had been applied to ore stripping. Two machines were used, one Bucyrus and one Marion. Their capacity has proved equal or superior to that of shovels, and they possess the very great advantage of being able to operate from a position high and dry to one side of and above the cut, while the shovel has to get into the bottom of the cut and work up.

It should be stated that the Balkan mine will be operated, partly at least, on the milling system. That is, the ore will be worked down from the surface through a conical hole or holes, and then transported horizontally underground to the hoisting shaft. The milling system, although distinct from the steam shovel openpit, requires that the overburden be stripped off just as clean.

Removing the bulk of the overburden is a relatively simple job compared with cleaning off the layer next the top of the ore. Systematic work is here badly broken up. The top of the ore resembles the surface of the ocean in a gale. It is necessary for the stripping shovel to leave each wave or pinnacle of ore and remove carefully all of the waste overburden from the hollows between. If it happens that the mine was formerly worked by underground methods, then the old workings, partly caved and partly open, add to the difficulty. Much of the Mesabi mining is done by companies who pay the land and ore owners so much per ton royalty. The stripping work is very largely done by contractors for these mining companies. The contractor, being paid by the cubic yard removed, has no great direct care whether or not good ore be sent to the stripping dump with the waste and waste be left to depreciate the value of the ore, although for the sake of his reputation he usu-

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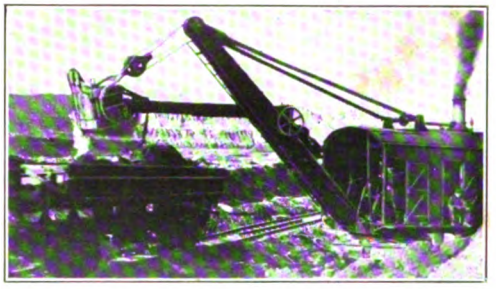
ally tries to do a clean job. The mining company, on the other hand, and the fee owner too, are extremely so-



TAKING THE LAST CUT

The Marion "merry-go-round" cleaning up for Butler Brothers. First tried for this work in the Longyear pit, the sides of which show in the background

licitous that no profitable ore be wasted by mixing with the stripping spoil, and the mining company again does not want any waste material left behind. Consequently, care is taken to clean off thoroughly the surface of the ore; horse scrapers are employed and even shovelers and wheelbarrows. It is impossible to tell in advance what the ore surface will be like in detail and the contractor makes or loses largely on his luck in finding it smooth or rough.

For taking off the last layer, Butler Bros., one of the stripping contractors, introduced, in 1913, a novelty in the shape of a revolving shovel, a "merry-go-round," as the scornful dubbed it. The revolving shovel is common enough in excavating work, but this was the first case of its being used on a stripping job. It was a distinct success; its lightness, flexibility, and grade-climbing capabilities rendered it peculiarly adapted for the work in hand, while its lower capacity was a consideration of little moment when the work was so very irregular. For getting into the smaller and more inaccessible holes, it could be fitted with a clam-shell bucket on a long boom.

Leaving the metal-mining fields, some remarkable achievements have

A COAL-STRIPPING OPERATION IN THE MIDDLE WEST

Note the enormous length of boom of the great Marion shovel in the background depositing its load on the top of the high waste dump

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been made in stripping coal beds in Kansas and Illinois. Conditions here permit the adoption of a radically different method. An iron or a copper deposit has a considerable thickness. Before it can be mined out for its full depth at any one place, some time must elapse, and meanwhile mining must be carried on over a large part of its lateral extent. This means that the overburden as stripped must be moved entirely off the deposit, usually to some distance so as to avoid the possibility of having to rehandle it. Coal beds, on the other hand, are relatively thin, and in the districts under consideration they lie flat, while coal is pretty uniform in quality compared with ore. Consequently as soon as a certain area is stripped, it can be mined clean at once and the stripping spoil from an adjoining area can then be thrown in this space; the spoil does not have to be loaded into cars and removed.

The work is carried on, as it were, in great windrows. The big stripping shovel makes a long cut down the property, throwing the waste to one side; then the coal-loading shovel, much smaller since the thickness of the coal is less than the thickness of the overburden, comes along and shovels the coal into cars; meanwhile the stripping shovel throws the overburden from the next cut into the space thus vacated. The work of the stripping shovel requires a boom of great reach. The dippers on the end run up to eight cubic yards in capacity. To handle this long boom with the great weight on it, the shovel structure has been developed to a size never before attempted. On the Mesabi, a 120-ton shovel is about the maximum in weight; the greatest of these coal strippers weighs 310 tons. It runs on two tracks spaced 30 feet center to center, and is carried by sixteen wheels. The upper frame revolves on the lower by means of a 30-foot turntable. The dipper holds six cubic yards and is handled with an 75-foot boom. The shovel makes a cut with a 106-foot radius. Capacities for this type of shovel range up to about 5,800 cubic yards per day and costs as low as 2.3 cents per cubic yard are reported. Certainly these are superdreadnaughts of digging machines.

Within a few months, a machine of this type has been put to work by Butler Brothers to strip an area on the western Mesabi. The innovation is interesting and important; its success has not yet been determined.

It is evident, then, that lately there have been important changes in the methods of stripping mineral deposits for mining. One new machine has been developed, the giant steam shovel just described; two standard excavators have been applied for the first time to this class of work, the dragline and the small revolving shovel; and, most interesting of all, hydraulic methods have been attempted and, in two cases at least, may be deemed successful. This last development, as being the most radical, is the most interesting. It seems not unlikely that, where conditions are favorable, hydraulic stripping will be applied with some frequency hereafter.

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THE TWENTY-FOUR HOUR DAY

By C. J. Morrison

Mr. Morrison's too brief article on the eight-hour day in our December issue of last year provoked a good deal of comment and discussion. Responding to our request for a reply to many inquiries, Mr. Morrison has further elaborated his position and strengthened it with the proof residing in numerous specific examples. The economies resulting from three-shift operation and the baselessness of the fear of over-production we consider he has pretty well established herein.—THE EDITORS.

MANY questions have been asked concerning "The Eight-Hour Day" published in the December issue, and this article is intended as an answer to these questions and not as an additional treatise on the subject. Data relative to the operating efficiency of various plants under different conditions of management and of hours of labor have been compiled for a number of years, and the statements made are deduced from these data and from personal experience. The statistics from any one plant are, of course, not conclusive and the complete data are too voluminous to be published. Furthermore, many of the data reveal the operating conditions in plants and therefore cannot be used where they would fall into the hands of competitors.

The practice of operating shops only during the day time is one of tradition rather than one of necessity, and has grown up slowly through the centuries until many regard it as a fixture which cannot be changed. Long ago when artificial light was in its infancy and shops consisted of a few workmen and their apprentices, work was of necessity performed only in the day time and as business grew the shops were enlarged and more workmen added in order that the work might be performed during the day. The idea of keeping the shop the same size and of operating two or three shifts was slow to materialize.

The first railroad trains ran only in the day time, but the railroad managers soon discovered that in order to make the large investment profitable, and to be able to sell their product, transportation, at a reasonable figure the plant must operate throughout the twenty-four hours of each day. No difficulty was experienced in obtaining men for night work and the question of day or night work has never been raised by the railroad employees. However, since the publication of "The Eight-Hour Day" in December the railroad engineers and firemen have demanded an eight-hour day.

Manufacturers of automobile tires found out early in their business experience that their plants must operate twenty-four hours a day if tires were to be produced at a price which would enable enormous quantities to be sold. For tire manufacture, the investments in buildings, machinery, tools and equipment, and the operating expenses, are so great that to run only eight or ten hours a day would make the price of tires prohibitive to any except the wealthy. Here again no difficulty has been had in getting men for night work.

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The telegraph companies faced the conditions of an enormous investment for outside plant which operated to full capacity only part of the time. "Night Letters" were instituted to increase the load during the slack hours. Every one is familiar with their success. "Day Letters" were also provided as fillers to be sent when the plant was not operating to full capacity. These devices did not detract from the regular business but enormously increased the total number of messages handled.

Many other industries, notably steel and paper, have discovered the necessity of operating twenty-four hours a day. Here again, were operations for only eight or ten hours, prices would soar.

The fear of over-production is ever present in the minds of many and is about as groundless as the old fear of the sea serpent. The history of civilization is a history of increased productivity. As man has produced more, he has had more to enjoy, and there is no reason to believe that this condition will not continue. Today the average man consumes far more than was possible a few generations ago and future generations will make our consumption look small.

Consider a few concrete examples within memory today. Pins were formerly a luxury and were carefully preserved and used many times, while today pins are so cheap that they are wasted by the thousand and no one ever thinks of saving a pin. Nails are no longer pulled out of boards, straightened and used over again. In fact nails are now so inexpensive that a carpenter who drops one is not allowed to pick it up, as his wages for doing so would exceed the cost of the nail. Shoes are no longer a treasure to be cared for so as to last many years. Transportation is so cheap that practically every one travels.

An almost endless history of increased production and of increased use could be written. There seems to be no such thing as over-production. Today the factories of the country are pressed to the limit to overcome the under production of the last two years. The slack business during these two years was not due to over-production but to the fact that the country was wearing out everything on hand and reducing its stores to an unsafe limit. Now comes the reaction which proves the point. To cite a concrete example, the railroads which are pressed to the limit to handle the traffic offered and are failing to do so, have their yards and shops full of equipment waiting for repairs. In many cases even the material required for these repairs is not on hand and cannot be obtained inside of many weeks.

A few concerns had the courage to operate at full capacity during the lean years and are now reaping the harvest.

These conditions regarding production must not be taken to mean that anything manufactured can be sold. A manufacturer must study conditions and keep abreast of the times, otherwise he may find that some improvement has put his product off the market. The country is full of examples of the fact that a plant can gradually improve its regular line or gradually change over to an entirely new line. These facts are demonstrated in numerous cases which the reader can readily call to mind. A few examples will serve to show this condition. As the demand for organs fell off factories were changed over to manufacture square pianos; and as the latter fell from favor further changes were successively made to accommodate the manufacture of upright pianos and then automatic players. Again we find a gradual and natural development in

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the manufacture of machine tools until suddenly, with the advent of high-speed steel, the old tools were not strong enough and a demand was created for a high-duty tool which, overnight, relegated the previous machine tools to the class of uneconomical equipment.

That there has been no difficulty in securing men for night shifts has been fully demonstrated. Where the three-shift plan is used with the shifts advancing one period each week the employees are well pleased. According to this plan the shift which works from 7 a. m. to 3 p. m. one week, works 3 p. m. to 11 p. m. the second week and 11 p. m. to 7 a. m. the third week. Workers who are employed eight hours a day do not have to spend their entire time off in eating and sleeping, but have leisure for duties around the home, for shopping, for amusements, and, what is most important, for study. Moreover, they get time off in the daylight no matter which shift they work. Men under these conditions are able to keep physically fit and to work at high efficiency.

The well-run shop operating under the ten-hour plan as efficiently as under the eight-hour plan has not yet been found. A well known plant in New England, famous all over the country for the excellence of its product and for its efficiency, operated until recently on a ten-hour day. The president was asked if he considered that he could operate his plant as efficiently on ten hours as on eight, and replied, "Emphatically no! No shop can. I run ten hours a day to protect my neighbors who wish to maintain the ten-hour day." A few months ago this plant changed over to three shifts of eight hours each per day and fully justified the president's theory by giving a greater output each shift than had formerly been obtained in ten hours of work.

A little over a year ago a plant whose product was made almost entirely on automatic or semi-automatic machines, practically all on piece work, tried an experiment. After the plant was boosted to the highest obtainable output on ten hours a day, a reduction was made to nine hours. At first the output fell off slightly, but soon rose to the former amount. The working hours were then reduced to eight with the same result of first a slight falling off, then a return of the output to the figures for ten hours.

Numerous other instances in different industries and under various conditions could be cited. All tend to show that men can give practically their full output in eight hours. When the day is longer, time slips away in small amounts in visiting, in rests, in the slower movements of the men, in slower mental reaction, etc. Much of the time lost is in minute fractions of a minute, but the total is large. Man's efficiency jumps up in an almost perpendicular line to the maximum then falls off very slowly until the point of fatigue is reached, where it drops off about half as rapidly as it rose.

Yet many concerns make a regular practice of employing tired men and of paying them extra wages for being tired. Many plants are at present running overtime three or four nights a week, thus tremendously reducing the unit production and paying extra wages. Wouldn't it be far better to run another shift of fresh men? The old objection always rises of obtaining men for the extra shift. For an answer, look around and note that some shops never have any difficulty getting all the men they need. There is something radically wrong with the shop that is habitually short of men.

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The question is not as stated by one correspondent, "Could we (not) do the best for all concerned by running the shop as well as we know how on ten hours rather than on shorter hours?" Unfortunately or fortunately, just as you choose to look at the matter, the question as to the length of the working day is being answered by the workers, and the question the management has to answer is how to operate on eight hours at a profit. A number have already answered by getting the value in productive work of every minute of the eight hours, while others have gone farther and are operating two or three eight-hour efficient shifts.

FUEL OIL FROM SHALE

By Dr. Arthur Selwyn-Brown

The world's reserves of petroleum are incomparably smaller than those of coal. Oil is one of our most precious possessions; it is fast being consumed; what shall we do when it is gone? One of the many answers to this problem is given here by Doctor Brown, as lying in the interesting possibilities of the highly carbonaceous shales.—THE EDITORS.

PRICES of commodities have advanced generally throughout the world during the past decade. The increase has been quite apparent in the past five years and notably so during the past year and at present. Naturally, fuels have shared in the rise. In many markets steam coals are quoted at such prohibitive prices that many users have been led to the substitution of oil fuel. The wonderful development of the oil motor, first in the automobile and more recently in the marine engine, has also stimulated the demand for oil. These factors, operating in conjunction with the various causes of the rise in commodity prices throughout the world, have increased oil prices, and the increased demand for oil and the high prices of all kinds of oils have greatly stimulated oil production.

The world's petroleum production prior to the war amounted to over 350,000,000 barrels per annum. The output steadily increased from 148,114,975 barrels in 1900 to 450,000,000 barrels in 1915. The world's crude oil production in the period 1900-1915 is shown in Table I.

The capacities of oil fields, unlike those of many coal fields, are limited, and producing wells have short lives. It is probable that the great profits in operating oil fields will continue to attract capital and new oil-bearing localities will be developed. But the world's oil deposits are limited and must be carefully conserved. The crude oil reserves are very much smaller than the coal reserves.

The natural oil deposits may, in time, be agumented by artificial oils. Petroleum has been prepared synthetically by a number of different reactions. Electrolytic methods, similar to those now largely employed in manufacturing acetylene, may be used in making petroleum. Indeed, petroleum can be made from acetylene.

At present the commercial oil is obtained from three sources: Oil wells, natural gas, and oil shale. Of these, the third source only will be discussed

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in this paper, and a review will be made of the world's oil shale deposits and the means employed in mining and extracting the oil.

Oil-bearing shales are divided into three classes: the albertite, the tasmanite, and the torbanite shales.

ALBERTITE

Albertite is a solidified mineral pitch, dark black in color, like hardened coal tar. It occurs in veins and in disseminated grains and globules in slate and arenaceous schists in permo-carboniferous areas. The largest deposit of pure albertite occurs in Albert County, New Brunswick, Canada. It yields between 90 and 120 gallons of oil and 80 and 90 pounds of ammonium sulphate per ton.

In many parts of the United States, in Western Canada, Queensland, and New Zealand there are large deposits of sandstones and shales richly impregnated with asphaltum which chemically resemble albertite.

TASMANITE

There is a peculiar deposit of fossil wax resembling amber found in a large deposit of arenaceous shale in Tasmania which has been called Tasmanite. It is mined on the north coast of the island in lower permo-carboniferous areas. Microscopical analyses indicate that the resinous bodies in the shales are fossil spore cases of primitive marine plants.

Tasmanite shales yield on distillation between 40 and 65 gallons of crude oil per ton and corresponding quantities of ammonium. The oil is very dark and viscous. Fractional distillation yields 64 per cent of lubricating oils, 25 per cent of lighting oils, and 11 per cent of benzine and benzolene. Commercial byproducts are:

Residues—knife polishes, brasque bricks, fire-brick materials, and fertilizer for agricultural lands.

Refinery products—sludge oil suitable for use in rope works, bases for the manufacture of dyes, cresols, drugs, paint oils, cement oils, and a hard graphite coke.

Refinery waters—ammonical bases and organic acids.

TABLE I—THE WORLD'S PETROLEUM PRODUCTION, 1900-1915

Year	Barrels	Year	Barrels
1900	148,114,975	1908	285,089,615
1901	165,773,361	1909	298,326,073
1902	185,158,022	1910	327,474,304
1903	194,588,558	1911	345,685,000
1904	218,955,279	1912	352,500,000
1905	215,040,917	1913	385,000,000
1906	212,912,860	1914	400,500,000
1907	264,249,119	1915	450,000,000

Cerous products—heavy oils, vaseline, anthracenes, japan black, paraffin.

The mining of tasmanite shales costs $1.50 per ton and retorting costs 60 cents. On an average return of 40 gallons per ton of shale, the profit amounts from $2 to $3 per ton, according to the fluctuations in the market values of the various products.

Tasmania is a great farming and fruit country and there is a good local market for all the spent shale from the retorts. The rock from which the oil has been taken sells at $2 per ton for agricultural uses. The average contents, as shown by numerous analyses, are as follows:

Carbon	10.10	per cent
Volatile matter	1.10	" "
Potassium	0.51	" "
Phosphoric acid	0.19	" "
Nitrogen	0.17	" "
Soluble matter	81.60	" "

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The assays do not disclose any rich fertilizing matter in the spent shale, yet when it is pulverized and distributed over farming lands and garden soils it produces such wonderful results as to make the demand for it greater than the supply. It appears to act on the soil mechanically by aerating it, and, possibly, by condensing moisture from the atmosphere and transferring it to the crops. It is expected that the prices obtainable for the spent shale will eventually cover mining and retorting costs.

TORBANITE

The principal commercial oil shale is generally known as torbanite. This name is derived from the Torbane Hill mine, Scotland, where the shale was first mined successfully. It is a brownish or dark black, fine-grained, schistose shale having a fawn-colored streak without luster and a sub-conchoidal fracture. It gives off curled flakes like shavings when scratched with a knife, and has a specific gravity between 1.10 and 1.31. It sometimes resembles coal, and when it was first worked in Scotland and Canada, many lawsuits arose over disputes under the mining laws. The Scotch case of Gillespie vs. Russel and the Canadian case of Gesner vs. Cairns are famous.

Mr. D. R. Steuart, chemist to the Broxburn Oil Company, Scotland, reporting on the shale from the Torbane Hill Mine, says: "It shows parallel banding by splitting, and although homogeneous in appearance in the fresh state, shows stratification when spent in the retorts. It is non-electric and consists of a mass of carbonaceous matter without structure mingled with stems or roots of trees and other vegetable as well as mineral fossils. When mined and broken up it has a gaseous smell; but afterward, when breathed upon it has a clayey odor. When powdered and moistened it is cohesive enough to make bricks. It does not deteriorate much by weathering. While being retorted, it sometimes sticks as a buttery mass which, when drawn out of the retorts, is as plastic as putty. Tested in a laboratory, it takes fire rapidly, splits but does not fuse, and burns with an empyreumatic odor, giving much smoke, and leaving a considerable amount of white ash. This ash is a most satisfactory and imperishable base for colors used in fresco painting.

"The character of the shale varies throughout the field and in different layers in the same place. The specific gravity runs from 1.17 to 1.316. The volatile hydrocarbons amount to between 66.0 to 70.1 per cent. Fixed carbon varies from 6.0 to 16.3 per cent and the ash usually runs from 12.8 to 23.2 per cent. The specific gravity is not proportionate to the ash. This indicates that the combustible part is of a variable nature. In distilling, the distillate is slightly acid at first and later becomes alkaline. The ultimate composition is shown in Table II.

TABLE II—CHEMICAL COMPOSITION OF TORBANITE

Carbon	65.72	64.02	60.25
Hydrogen	9.03	8.90	8.80
Nitrogen	0.72	0.55	1.53
Sulphur	0.01	0.50	0.13
Oxygen	4.78	5.66	3.62
Ash	19.75	20.32	25.60

"From the analyses of many samples we find that torbanite consists of from 20 to 30 per cent of clayey matter, mixed with carbon compounds of complex constitution, which are not soluble in benzene, turpentine, carbon bisulphide, or petroleum spirit, and

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they are not of the nature, therefore, of petroleum, resin, or true bitumen; at any rate, only a very small proportion is soluble. It gives petroleum-like products by distillation at a gentle heat."

A number of analyses of various kinds of coal and albertite, torbanite, and stellarite showing their chemical affinities are given in Table III.

It will be noticed on referring to Table III that while there is a general resemblance between the compositions of the oil shales and the various kinds of coal, there is a wide difference shown in the last column. The ratios of carbon to hydrogen in the oil shales is much greater than in the coals, excepting certain cannel coals which are almost indistinguishable from oil shales. It is apparent from the ratios in the last column that the oil shales are prolific gas producers. Some of the Canadian shales yield from 10,000 to 13,000 cubic feet of gas of 36 candle-power per ton of shale. The amount of fixed carbon, however, is much higher in the coals than in the oil shales.

TABLE III—ANALYSES OF OIL SHALES AND COALS

Mineral	Locality	Proximate Analyses					Ultimate Analyses				
		Specific Gravity	Volatile Matter	Fixed Carbon	Ash	Carbon	H	N	S	O	Ratio of C to H
Torbanite	Scotland	1.170	71.17	7.65	21.18	66.00	8.58	0.55	0.70	2.99	100:13.00
Albertite	New Brunswick	1.091	54.39	45.44	0.17	87.25	9.62	1.75	....	....	100:11.02
Stellarite	Nova Scotia	1.103	66.53	25.23	8.21	80.96	10.15	0.68	....	....	100:12.53
Welsh Bituminous Coal	Duffryn	1.326	15.70	81.04	3.26	88.26	4.66	1.45	1.77	0.60	100: 4.82
Scotch Bituminous Coal	Grangemouth	1.290	43.40	53.08	3.52	79.85	5.28	1.35	1.42	8.58	100: 6.61
English Bituminous Coal	Broomhill	1.025	40.80	56.13	3.07	81.70	6.17	1.84	2.85	4.37	100: 7.55
English Cannel	Wigan	1.276	39.64	57.66	2.70	80.07	5.53	2.12	1.50	8.08	100: 6.90
Scotch Cannel	Leshmahagow	1.251	56.70	37.26	6.03	73.44	7.62	2.00	1.14	9.76	100:10.43

OCCURRENCE OF OIL SHALES

Petroleum shales occur in bedded deposits in similar formations to coal. On many of the oil-shale fields, like those of Nova Scotia, Newfoundland, Scotland, and New South Wales, coal seams exist above the shale beds.

Oil shales also occur in irregular blocks interspersed in sedimentary deposits; but such deposits are of little commercial importance. Only the large bedded deposits that can be extensively and cheaply mined can be profitably operated.

ORIGIN OF THE SHALES

The numerous lycopodiaceous spores found in most oil shales indicate that the organic matter originated from changes undergone by vegetable matter deposited in coastal lagoons and shallow lakes.

The usual solvents for paraffin and resin do not dissolve anything from oil-shales. This indicates that petroleum, bitumen, and paraffin, are not contained in the shales in a free state. The organic matter on being attacked by the metallic oxides has been converted into an insoluble carbonaceous compound known as kerogen.

There appears to be a gradation in oil contents from peat up to the highest grades of torbanite. The paraffin and oil contents of peat are small, of bituminous coal moderate, and of albertite and torbanite high. Some of the torbanite from New South Wales carries as much as 125 gallons of oil per ton. It is also found that the crude oil contents diminish and the ammonia increases proportionately with the age of the shales. Recent experiments show that fresh wood, when subjected to destructive distillation, gives off a very acid distillate; peat a

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less acid; bituminous coal, much less acid; while the first distillate from torbanite is slightly acid, the final part is alkaline. This indicates that age greatly modifies oil shale, and that pressure and heat acting over long periods of time change both the chemical and physical characteristics.

Mining Methods

The shale beds are mined exactly like coal deposits. Some of the large commercially valuable deposits outcrop on the surface, like the Newfoundland deposits and parts of the New Brunswick deposits, and can be openly quarried. Other deposits are deep down in the earth and are covered by other rock formations. These have to be developed by the sinking of vertical shafts. The principal deposits now being operated are in inclined beds and are mined through slopes following the angles of the dip.

When the mines are opened out by shafts or slopes, levels are run and connected together as in coal mines. Then the beds are prepared for working either on the long wall or the pillar and stall systems.

Distillation

The shale, when taken out of the mine, is crushed into coarse blocks about the size of an ordinary brick. It is then fed into large hoppers placed above the retorts, but connected with them so that they can be automatically fed. The distilling plants, in order to save carriage costs, are always erected on the mines. The retorts are large brick and cast-iron stacks with which the shale is fed at the top. The Bryson retort, used largely in Scotland, is a double shaft retort. It is 34 feet in height. The bottom part, built of bricks, is 20 feet high and the remaining 14 feet is built of cast iron. Each shaft is 2 feet 9 inches by 1 foot 3 inches in width at the top and 4 feet 8 inches by 1 foot 10 inches at the base of the brick part. The retorts stand on a base of stone, concrete, or bricks about 20 feet in height—making the hopper feeds 63 feet above the ground. Each retort holds 15 tons of shale. At the base of the brick portion of the retorts there is a revolving cast-iron bottom which stirs up the shale and automatically discharges the spent shale into a hopper and on to a revolving belt which takes it away to the spent shale dump. A single retort extracts the total oil and ammonium contents from four tons of shale every twenty-four hours. Consequently, in order to handle 1,000 tons daily, it is necessary to provide benches containing 250 retorts.

The retorts are fired by gases from the distilling works. The gases given off from the shale are drawn into collecting chambers and passed through ordinary water-cooled pipe condensers made from four-inch pipes arranged in long vertical stacks. Ammonia water and crude oil are collected in the condensers and drawn into tanks. The water settles in the tanks while the oil rises to the surface and is drawn off into other tanks and separators.

It is found that some of the gas cannot be condensed in the condensers. This is called the permanent gas. It is cooled in an ice machine and compressed in a power compressor. By these means a certain amount of gasolene is secured from it. The balance of the gas from the compressor is stored in gasometers and is used for fuel purposes.

The crude oil is treated exactly as oil from the oil wells is treated in the refineries. A refinery is furnished with: (1) still for the repeated fractional distillation of the oil, by which means oils of varying specific gravities are secured; (2) stirring tanks in which the oil is treated with either sulphuric acid or caustic soda to separate tar, ammonia, and other sub-

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stances; (3) paraffin ovens and refrigeration machinery; (4) paraffin refinery; (5) stock tanks for storing finished oils; (6) cooperage and can making plants; (7) acid chambers for making sulphuric acid; (8) candle and soap works; (9) works for making up lubricating oil and grease mixtures; (10) works for making special petroleum chemicals, remedies, and products.

The refining processes and machinery are modified to suit local conditions met with at the different mining localities. Those, like the Scotch mines, that are situated close to large cities and markets are larger and more complex than plants in remote places. Generally speaking, however, an oil-shale refining plant is similar to plants for refining petroleum.

Distribution of Oil Shales

While many of the known oil-shale areas are very extensive, the distribution of the shales is restricted to a few countries. They occur in the United States, Canada, Newfoundland, Australia, Tasmania, South Africa, and Scotland. Specimens have been found in Mexico and Servia. It is only a few of the known deposits that are sufficiently rich in oil and ammonium sulphate to warrant development at present. Remoteness from markets will also prevent some rich deposits from being worked. Later, however, when working facilities are improved and there is a keener demand for the various oil shale deposits, some of the remote deposits, like those in Colorado and Utah, will be extensively operated.

The United States Deposits

Oil-bearing shales and sands occur in many parts of the United States. Some of the deposits in Utah, Colorado, and Oklahoma are of apparently great size. But the economic value of these great sources of petroleum has not been recognized and none of the deposits has been geologically surveyed. Even the United States Geological Survey in dealing with the Mineral Resources of the United States has overlooked them. The principal references to them in their publications are in a report on Asphalt and Bituminous Rock Deposits, by George H. Eldrige, published in 1901.* A detailed study of these shales was recently made by Messrs. Woodruff and Day.†

The best known American deposits occur in Utah, Colorado, California, and Oklahoma. Specimens of oil-shales have been found in Texas, Missouri, Kentucky, Wyoming, and West Virginia.

The largest outcrop at present known in the United States is found on the Great Book Cliff Plateau, in Northwestern Colorado, which extends for several hundred miles from the Grand River into Utah. These shales closely resemble the shales found in the Maritime Provinces in Canada and appear to be equally rich in petroleum and ammonia.

Canadian Deposits

The Canadian oil-shale deposits are among the largest and richest in the world. They cover extensive areas in New Brunswick, Nova Scotia, and Ontario. There is a rich belt starting near the Memramcook River, in Albert County, New Brunswick, and running a little west of the City of St. St. John, a distance of more than 70 miles. This shale belt outcrops frequently and is, in places, several hundred feet in width. These shales have been commercially tested and are of great industrial value. They are, however, locked up for speculative purposes, having been withdrawn several years ago from the operation of the New Brunswick mining laws by the Dominion Parliament.

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* See 22nd Annual Report, U. S. Geological Survey, 1900-1, part 1, pp. 219-452.

† See Oil Shales of Northwestern Colorado and Northeastern Utah, U. S. Geological Survey, Bulletin 581-A, 1914.

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Development work has been done on the Albert mine to a depth of 1,500 feet. This mine started work on an albertite vein in 1850 and was successfully operated for many years. The albertite was enclosed in a bed of oil shales nearly 200 feet in width. These shales have not been worked, but numerous assays show them to be very rich in petroleum and ammonia. A large part of them will yield average returns of 40 gallons of oil and 32 pounds of ammonium sulphate per ton.

The commercial value of these shales has been recently tested in Scotland. The cost of mining and distilling the shale in the Maritime Provinces amounts to $2 per ton. Taking the price of ammonium sulphate at 3 cents per pound and crude oil at 10 cents per gallon, the shale is worth nearly $5 per ton. It could be mined and distilled so as to yield a profit of $3 per ton.

Across the Peticodiac River, from the Albert Mine, and near Moncton, a new belt of shales start and run across Nova Scotia to the St. Lawrence River. Some years ago this shale was worked near Stellarton. When retorted in the Pictou gas retorts it yielded 11,000 cubic feet of illuminating gas of 36 candle-power per ton of shale. Assays show it to contain from 35 to 45 gallons of petroleum and 30 pounds of ammonium sulphate per ton. The thickness of the shale beds in Nova Scotia runs from 10 to 100 feet. Assays of Canadian oil shales are given in Table IV.

TABLE IV—ASSAYS OF CANADIAN OIL SHALES

Locality	Imperial Gallons Crude Oil, Per Ton	U. S. Gallons Crude Oil	Specific Gravity of Oil	Sulphate of Ammonia in Pounds Per Ton
Irvings, N. B.	40	48	0.92	77
Baltimore, N. B.	54	65	0.895	110
Baltimore N B	49	59	0.892	67
Posser Brook, N. B.	30	35	0.895	75
Taylorville, N. B.	43	51	0.900	93
Taylorville, N. B.	37	44	0.925	110
Baltimore, N. B.	51	61	0.910	111
Newfoundland	42	51	0.870	80

NEWFOUNDLAND DEPOSITS

Oil-bearing shales occur in several districts in Newfoundland. A large deposit runs through the City of St. John's. Another deposit occurs on the western shore of White Bay, on the North Coast. The largest and most valuable deposit, however, runs north from Deer and Grand Lakes to the head of White Bay. This deposit is of great commercial importance and is being developed. The shale is identical in geological features and in oil contents with the deposits in Nova Scotia and Cape Breton Island. This series of shales covers an area of about 750 square miles, averages between 35 and 50 gallons of oil and 30 pounds of ammonium sulphate per ton and is from 50 to 100 feet in thickness. The deposits near Deer Lake outcrop boldly and can be mined by quarrying in many places. Further north, they dip at low angles. They have been well tested by drilling and assays and their great prospective value has attracted capital for development purposes.

THE SCOTCH DEPOSITS

The Scotch shale deposits were the first to be commercially developed and they are now the greatest oil producers. They are situated close to

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Edinburgh and cover an area of about 70 square miles in the Midlothian, West Lothian, and Fife districts. They occur in lower carboniferous formations which outcrop in many places, and dip at steep angles, so that they have to be in all cases worked by shafts or slopes.

The Scotch oil-shale industry was started by the firm of Young, Meldrum and Binny, now known as Young's Petroleum Co., Limited, in 1850. This firm held patents for oil refining which kept the industry back for many years; but when Young's patents expired in 1864, there was a boom in the promotion of Scotch oil-shale mines and the industry has continued to prosper ever since. It is now very successfully and profitably carried on and continues to expand. The present output of shale is 3,500,000 tons valued at $15,000,000 per annum. The mining, refining, and manufacturing industries connected with the business give employment to 12,500 men. The refineries, four of which are now operating on the shale, produce yearly the following products:

Burning oils	20,000,000 gallons
Naphtha	5,000,000 "
Lubricating oils	22,000,000 "
Paraffin wax	25,000 tons
Sulphate of Ammonia.	54,000 "

These refineries make special oils for lighthouses and have valuable contracts with the Admiralty for supplying oil fuel for the British warships. Their products are well established in the European markets and always find ready sales.

South African Oil Shales

Oil-shale deposits occur in the Middleburg coal district, in the Transvaal. The beds have an average thickness of six feet and the oil contents vary between 30 and 40 gallons per ton. High yields of sulphate of ammonia have been given in many experiments. Several companies have been formed to develop the deposits.

Australian Shales

Extensive deposits of rich oil shales occur in the Blue Mountains, New South Wales. They were first mined at Joaja Creek thirty years ago and have been successfully operated during this period. Recently two large English companies have erected large refineries in the shale districts and when these plants are regularly operating the oil production will be largely increased. The shales yield 17,600 cubic feet of 49-candle-power illuminating gas, or 100 gallons of petroleum, and 70 pounds of ammonium sulphate per ton. The crude oil yields by fractional distillation the following products:

Naphtha	8.48 per cent
Illuminating oil	19.50 "
Gas oil	15.87 "
Lubricating oil	22.80 "
Wax	6.42 "
Residue	3.28 "
Tar and heavy oils	24.65 "

Conclusion

The various countries referred to above possess valuable deposits of oil-bearing shales which can be profitably made to yield, not only oil, but many valuable byproducts. They have been successfully worked in Scotland and New South Wales for many years, and these operations, besides being profitable to the companies engaged in the industries, conclusively show that oil shales carrying not less than 20 gallons of oil and 19 pounds of sulphate of ammonia per ton can be successfully developed whenever cheap mining conditions exist. The deposits in Newfoundland, Canada, and the United States are extensive and rich, and it is only a question of a short time, before they will be developed so as to augment the annual petroleum output, establish several new industries, and furnish employment for many thousands of men.

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SALES VERSUS OPERATING DEPARTMENT

By Dwight T. Farnham

Co-operation is the keynote which Mr. Farnham sounds in this short paper. No matter how good the product may be, no matter how cheaply it may be made or sold, if there is not perfect understanding between the manufacturing and the sales departments of the limitations of each, the sure result will be dissatisfaction by the consumer. A close relationship between the two is the remedy.—THE EDITORS.

UNFORTUNATELY, the title expresses the usual mutual attitude of the sales and the operating departments of any large corporation. No matter how agreeable the General Sales Manager and the General Superintendent are to each other socially, no matter how high the quality of the personnel in each department, and no matter how capable and carefully organized the commanding executive force, there is always present a latent suspicion and antagonism which, unless understood and controlled, continually takes its pound of flesh from the net profits.

The fundamental cause of this antagonism lies in the temperamental difference between the type which succeeds as salesman and the type which succeeds as superintendent. The good salesman is an optimist. He must believe in his goods regardless of their real quality and worth in order to make others believe in them—even when their quality wouldn't deceive a blind man at midnight. He must be an enthusiast, no matter how black the business outlook, or his sales volume would be negligible; and he must have a personality force almost equivalent to hypnotism. Therefore, as a result of a continued and necessary effort to deceive himself—or, at least, to select the most favorable aspects of any situation and then to persuade himself that these are all facts—it becomes very easy for him to believe what he wants to believe or what the ethics of the situation demand he believe. In time, this cannot help but leave a permanent impression upon that part of his mind which controls his mental processes, and it becomes difficult for him to form complete judgments and to reach entirely unbiased decisions. There is a tendency also to exaggeration—as one man expressed it, "When two black cats are howling on the back fence, the successful salesman must be able to convince himself that the back yard is full of black cats." The Hamlet type, the man who sees all of both sides and speculates and analyzes, who hesitates rather than acts, is no salesman. The man of judicial temperament, who weighs both sides with exceeding accuracy (instead of coming out strongly for his own side, believing "there may be something in the other fellows side, but that's his business—not mine") is not likely to prosper as a promoter. Belief in himself, belief in the goods he is selling, the firm conviction that he is doing all mankind a service in allowing them to purchase, and the ability to tell people about it in interesting fashion are the requisites of a good salesman.

The successful superintendent or factory manager is almost the exact opposite. He must be able to analyze

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conditions in such a fashion that he secures *all* the facts. He must be able to spread these facts out upon the table before him, as it were, determine their exact relative importance, discard all irrelevant matter, and, overlooking nothing, reach a decision. He must reach his conclusion *after* an accurate and exhaustive examination. The salesman is furnished his conclusion at the start being told, "the goods are O. K., go out and sell 'em," and thereupon must build up and arrange his facts to prove this conclusion.

The superintendent deals with things tangible—materials, machines, the productivity of the man-hour. To him the personal equation is only one factor in a dozen. To the salesman the personal equation is everything. The factory manager can plan his work a long way ahead. The salesman knows not at what time a poorly digested dinner may upset his best laid plan of campaign. The factory manager regards himself as prudent and farsighted and the salesman as a creature of the moment—a person of whims, unstable as the summer breeze. Why should the salesman plan elaborately? Detailed plans would only be an encumbrance. He can lay out beforehand the general line he wishes to take, but just what he does and says must be determined on the instant.

The judicial temperament is an asset to the factory manager. He must be able to weigh both sides. His men must be treated fairly. Very often he must even protect them against themselves. He must be enough of a pessimist to foresee the possible dangers and to guard against them. He must also have a personality force. But as most of his viewpoints differ radically from those of the salesman, these make for antagonism rather than for harmony.

The man at the head of an operating organization must always state his case exactly, in a phraseology almost legal in its brevity, so that there may be no chance of a misunderstanding. As a result the superintendent is likely to regard the salesman—with his statements based upon a single premise and with his exaggerations of fact—as something closely akin to a liar. He is likely to look upon the salesman's volubility with much the same feeling of silent contempt as that with which a sage might regard a chattering popinjay. If he envy his rival's facility of expression, his silence and contempt is only likely to be the greater. The superintendent has probably fought his way up through flannel shirt and dinner bucket and takes a certain pride in roughness and masculinity. He is therefore likely to regard the man in the silk shirt, whom he regards, perhaps, somewhat in the light of a pampered patron of the lobster palace and the peroxide manicurist, with a mixture of awe and contempt.

This may be drawing it a trifle strong, but it is nevertheless the fact that the early and subsequent environments of the two types differ widely in most cases. The characteristics which make for success in the production department differ widely from those that should prevail in the sales department. The result is a temperamental difference, continually cropping out. It is simply a condition to be met, and the best general managers realize this fact and provide accordingly.

The advantages to be gained by means of a harmonious co-operation between the sales and the operating departments are of almost incalculable value. Take perhaps the commonest case of inefficiency—the interruption of production by rush orders. In the factory, the work for the pe-

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riod—a month or a week or whatever it may be—is planned in advance and the material ordered. A consistent adherence to this plan is essential to economical operation. In the middle of the period, the sales department sends in a rush order. Some customer has been caught short, or a new customer can be obtained by the promise of early deliveries. The factory's plan is completely upset, departments are thrown out of balance, overtime lowers the efficiency of the operating force and the superintendent is furious, knowing as he does that he will be held accountable for the cost per unit which must inevitably rise.

Take another instance: The Sales Manager promises a certain delivery, perhaps without conferring with the Superintendent, or, perhaps, the Superintendent, somewhat in awe of his more brilliant compeer, is carried off his feet by arguments and promises a delivery earlier than his best judgment warrants. The factory falls down on delivery. The customer is enraged and the Sales Manager is frantic.

In either case mutual recrimination and ill feeling is the result. Both departments fall in efficiency. Factory costs increase, the sales department's hold upon its customers is weakened, and the net profits suffer.

The remedies differ somewhat with the nature of the business. Roughly business may be classified into three divisions:

1. Monopolistic: In which the corporation occupies a position almost unassailable as far as competition is concerned, such as the possession of a patent, a corner on a raw material, or a franchise. The attitude of the sales department in this instance might be described as aristocratic.

2. Strategic: In which the corporation has a less strong but still a definite advantage over its competitors, such as being the first in a given field, well established enough or large enough to dominate the situation. Or, a company may be better organized and by means of lower costs or better quality have a surer hold upon the public. The attitude of the sales department in this case may be characterized as self-respecting.

3. Competitive: The distinction between this class and the previous is somewhat more difficult to describe, but it includes such concerns as have no distinct advantage over their competitors but depend for their sales upon cutting prices, the creation of a clientele, public favor, upon political pull, etc. Department stores with their absurd service features fall into this class; manufacturers selling to public corporations, county, state, and city governments; besides all sorts of minor concerns, tailing off down to the corner grocer or drug store which must hold business against its rival across the way. The attitude of the selling force in such a business may be described as subservient.

In the case of the first class, the sales manager is a distributer rather than a salesman. The demand for the goods is greater than the supply and the sales manager decides who shall be favored. Salesmanship is a thing unknown and unnecessary. In one such concern known to the writer, the General Sales Manager was popularly known throughout the field as the General Excuse Agent of the company. He didn't have to sell goods—his job was to calm down clamoring customers—to explain to them why their orders hadn't been filled and to feed them any sort of soothing syrup which would stifle their cries. In this case the pressure had become so great finally, that the Sales Manager, driven nearly frantic, was promising any delivery demanded, no matter how ri-

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diculous. Customers were disappointed, of course, when the goods arrived away behind schedule, as it meant in many cases heavy loss to them. The firm got the reputation of not living up to its promises and, as a result, the next time any customer placed an order he endeavored to protect himself by demanding delivery in even shorter time, hoping that a promise for thirty-day delivery would give him the sixty-day shipment he needed. When this plan became universal among customers and the follow-up systems were in full operation, beginning with the soft pedal at thirty days and ending in a perfect bellow of rage and recrimination about the sixtieth day, the life of the General Excuse Agent was one of anguish and misery.

The only vent for his wrath was the factory "which hadn't turned out the goods—which was responsible for his breaking his promise—which was giving the company a bad reputation, etc., etc." Customers began to phone and write to the factory direct: "We don't want to talk to the Sales Manager—wouldn't believe him on a stack of bibles as high as Pike's Peak—what we want to know is *when we are going to get the goods*, etc., etc."

The Factory Manager finally got tired of this sort of thing and called a conference of the executive heads. At this conference it was decided, first, that no rush orders were to be accepted without consultation with the factory; second, that the decision as to date of delivery should rest with the factory; and third, that ten per cent should in every case be added by the sales department to the delivery time set by the factory *and that no amount of argument, exhortation, or threatening on the part of the customer should be allowed to force the sales department to concede one day on such delivery.*

This may seem rather drastic action, but the results justified the means. Within three months the harried look had left the Sales Manager's face. He only had to have his fight once—at the beginning when the delivery date was settled. When the goods reached the customer from seven to ten days before they were promised, his compliments were from the heart. Within six months the attitude toward that company throughout the entire district changed. Customers believed what they were told. They regained confidence in the company, the Sales Manager had leisure to consider pushing other lines, and overtime, congestion, and inefficiency at the factory became a thing of the past.

It would not be possible to adopt quite this plan of procedure in the second sort of business. If the customer is told flatly, even if tactfully, that he can't have the goods until such and such a date, long in advance in many cases, he will forego his preference and buy from your competitor. For that reason the arbitrary law, which places the decision as to date in the hands of the productive department, is out of the question. The case must be more carefully considered.

The policy adopted by a certain large concern controlling some twenty factories, each with its own selling force, meets the situation admirably. Formerly, it had been the custom for the Sales Manager in one of these factories, a plant employing some two thousand men, to rush into the office of the Production Manager with orders to turn out a certain number of, say, 34 industrial locomotives, by such a date. The Production Manager might protest that it would interfere with the other work, but would be beaten down by the superior personality of the Sales Manager, who was

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well equipped to prove his point and was inclined to regard the factory as chronically overloaded and protesting anyway. Schedules were upset, and the usual inefficiencies in both departments resulted. Conditions became worse and worse, until finally the rule was laid down that *no production orders should be accepted by the factory unless signed by the General Manager.*

What happened as a result of the order was this: When the sales department secured an order demanding early delivery, the Sales Manager went to the Production Manager—not to bluff and brow-beat him—but to see what the factory could do. The planning sheet was brought out, and the exact relative importance of the new order, to the orders already scheduled, was decided in conference. If the new order were more important, it replaced some old order. That was the only decision allowed the sales manager—and it was a decision within his province, since he, of all the organiation, was most closely in touch with his customers, their needs, and the chance of losing them. This point decided the production order then passed through the usual channels, the credit was O. K'd, etc., and came to the General Manager for signature. *Then* it became an order to the factory and not before. This plan made the General Manager a court of last resort and assured to both sides a fair and complete hearing in case of dispute. It also brought the sales and production departments together on a basis which had never existed before. Mutual respect born from a mutual understanding of each other's problems and difficulties, frankly discussed, made possible economies in the factory and changes in the product. This mades sales easier and resulted in increased efficiency in both departments.

In the third sort of business the sales force is supreme. Owing to severe competition the customer must always be placated by earlier deliveries, better service, or by some other desired concession. The factory must bow to the will of the sales department, and if inefficiencies result in high costs of production, the business is doomed; the fault lies with the original investor and cannot be remedied by any work of the existing executive force.

The value of a close relation between the members of the sales and manufacturing forces is becoming understood more and more in our large corporations. The problem is a difficult one owing to the different training and mental attitude of the respective personnels. The first requisite for a proper understanding is the placing of the two departments upon a basis where they will have an equal right and opportunity to be heard. Add to this an education in the problems of each other, encourage suggestions as to changes in either department which will assist the other, and place the final decision where it belongs—in the hands of a just general manager who recognizes the temperamental differences in the two types. Such a plan will result in increased efficiency in both departments and an increase in the net profits.

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EDITORIAL COMMENT

THE GERMAN WAR MACHINE

WE rather expected that Mr. Knoeppel's initial chapter last month would lay him open to the charge of advocating Prussian militarism or the adoption by this country of the German industrial system. We were amazed, however, at the accusation from a loyal American that we were lending our pages to a skillfully disguised pro-German propaganda; especially so, as we had previously seriously considered the necessity of allowing him space in which to declare both his ancestry and his neutrality. There may be other readers who have not voiced their suspicions, and hence we take this opportunity to proclaim that Mr. Knoeppel is as ardently American as is THE ENGINEERING MAGAZINE, and his only purpose in the series now appearing is to lay stress on the spirit of efficiency exhibited by the German War Machine. To catch his point requires an absolute detachment from sentiment. For the purpose of his argument he is assuming an utter lack of bias and is regarding the German military method as an utterly impersonal machine. His arguments are just as neutral and just as unbiased as though he had chosen the efficiency of the Carranzista forces against the Villista forces in Mexico for his examples. In such case, however, the principles of efficiency he is laying stress upon would have been conspicuous by their absence.

As to the other point—advocacy of the German industrial system—we believe that the remaining essays will clear up any misapprehension that may exist. Those of our readers, however, who are familiar with Mr. Knoeppel's previous writings and who are also familiar with the German system, will appreciate how radically he would oppose the introduction of such a system into American industry.

There can be no question that the Germans have attained a high degree of industrial efficiency. That efficiency has been adopted to a large measure in their military system. There are undoubtedly evils in that system, but there are many extremely good points in it as well, which could be adapted to American industries to good purpose.

Frederic C. Howe, the eminent authority, in his recent book, "Socialized Germany," written after twenty-five years of intimate study, states:

"We may deplore the Prussianizing process, but at the same time admit that there is much that is wonderful in the structure that has been erected during the past generation; a structure like that of ancient Rome in the institutions that have been created, and the big-visioned ideas of legislation, of education, and of social activities that have been given to the world. These ideas will only be ignored by those who will not see. And it will be an unfortunate thing for the nation that refuses to see. For once the war is over, the pace for industrial supremacy will be fierce and rapid. . . .

"When we consider the universities, technical schools, commercial colleges, and special schools of various kinds, enrolling several hundred thousand students, specializing to the last degree along every line of thought, science, and industry, and compare this provision for the training of a

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nation with the educational equipment of England, France, or even the United States, we find an explanation, for the most part an overlooked explanation, of the foundations of modern Germany; of the industrial discoveries, the contributions of science to industry, the development of the byproduct, of intensive mining and agriculture, and the expansion of the state from an agricultural country of a generation ago into the most dominating industrial nation of modern Europe."

And while he holds up certain features of the German social system for admiration, yet he sees most distinctly that there are many points in which that system fails.

"The German artisan works long hours at exhausting labor; his wages are low in comparison with those which prevail in America; housing conditions are very bad, not only in the city but in the country, and the worker is far from enjoying the freedom of action of the hopeful outlook of this country. Poverty of the most distressing kind still prevails, the life of the people is in many ways poor and sordid, the unrest of the workers and their political demands are all justified by conditions. It would be false to suggest that Germany had made any revolutionary changes in these matters or aimed at a programme of industrial justice or political equality. . . .

"There are faults in the system. There is a terrible pressure of highly educated men struggling for every opening. There is complaint of overwork, of defective eyes and even defective physique as a result of overtraining and too great pressure. There is undoubtedly individual waste and countless disappointed ambitions. All these are vicarious costs which the expansion of higher education involves in a country of relatively limited opportunities. It has created new industries. The wonder is not that the overcrowding is so great, but that it is relatively so little, in view of all the conditions."

It is the good points of the system that our manufacturers want to adopt; it is the bad points that they want to understand so that they may intelligently overcome them.

THE EIGHT-HOUR DAY

SOME of our correspondents have accused us of partisanship with the labor unions in advocating the adoption of an eight-hour day. That, however, is beside the point. We believe absolutely that the universal adoption of the short working day *will* take place within a relatively short time, and hence our object has been to point out to manufacturers what others have done and what they can do in preparing for this demand.

The eight-hour day has proven a commercial success in many lines of industry—few enterprises can point to that as the cause of failure. Those who followed the Ford series in these pages, and those who have had the opportunity to visit the Ford plant in Detroit know how enthusiastic both management and men are over the actual working of the three-shift plan.

Men will not and cannot work as vigorously for ten hours, or even for nine hours, as they will for eight. This has been indisputably demonstrated by many close analysts. And Mr. Morrison's arguments that men will do as much work in an eight-hour day are amply supported by the testimony of many others. Furthermore, it must be remembered by all employers that the chief aim of man is not work, and that, therefore, any toil which leaves him no time for his own cannot but prove irksome, and will most certainly be shirked by him.

A prominent New England manufacturer remarked recently that he himself didn't like night work, and, therefore, he didn't propose making his employees do what he himself disliked. This sounds like the true principles of leadership; but, is it? How does this man know that his employees would not prefer night work, especially when such work would allow them some daylight hours to themselves and when, as now, under the present ten-hour day, they have little opportunity for their own gardening or sports?

Mr. Morrison has made the argu-

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ment that a certain amount of overhead goes on just the same during the night hours when the plant is idle. This is so obvious that we will not discuss it at length. One of our correspondents, however, advanced the question, whether by adopting the three-shift method and thereby producing three times his normal output, he might not have difficulty in selling his product. Such a predicament would be a rarity, but if it actually existed the answer would be: If he can maintain his required output by utilizing one-third of his present equipment working three times as long, it would be folly for him not to sell or scrap his excess equipment.

It behooves the industrial manager to study this question from every angle, for it is certainly something he will be forced to act upon in the near future. Unorganized labor as well as organized labor is forcing the issue, and much more credit will be given to that employer who voluntarily adopts the short day than to him who is compelled to do so. Undoubtedly there are many stumbling blocks to be avoided, and many hardships will result, but much trouble can be avoided by studious foresight.

FACTORY PLANTS

IN all the arguments that have been advanced for a shorter working day, that of the same amount of work being turned out in less time is the strongest. For if a manager knows to a certainty that his ledger account will not be damaged by decreased hours of labor, he will turn a much more attentive ear to the appeal. But, unless his plant be an exception, he need expect no such returns without providing the facilities. No man can perform a fair day's work in a poorly lighted, ill ventilated, or unsanitary shop no matter how hard he may work, and it is generally in such shops that the ten-hour day is in force.

INDUSTRIAL HOUSING

THE National Americanization Committee has undertaken a good work. According to a recent announcement they have offered a competitive prize for plans for the housing of immigrants in industrial towns. This problem has always been an important one, although it is more noticeable in the small industrial towns around new industries. The du Pont Powder Company in establishing their plant at Hopedale, Virginia, is a case at issue. Workmen, especially immigrants, flock to such a town where jobs are plentiful, and turn disappointedly away because there are no dwellings for them. If left to themselves the newly arrived immigrants will put up shanties or live in squalid conditions which will reflect markedly upon their efficiency. Such a community cannot be regarded as American. The aim of this competition is to arouse interest and to produce carefully worked out and entirely practicable housing plans and standards which it will be possible for employers, workmen, and communities alike to demand and insist upon.

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REVIEWS-ADVANCED PRACTICE

NOTABLE ARTICLES OF THE MONTH IN THE SOCIETY PROCEEDINGS AND TECHNICAL PRESS OF EUROPE AND AMERICA

ENGINEERING FOR THE HOUSEHOLDER

VENTILATION, WINDOW LEAKAGE, FURNACE EFFICIENCY, LIGHT ABSORPTION

IN the *Journal of the American Society of Heating and Ventilating Engineers* for January, are published a number of articles which bear on one phase or another of the maintenance of proper atmospheres in dwelling houses. One containing an unusual quantity of practical advice is contributed by George Beaumont, J. W. Shepherd and Samuel R. Lewis, of the Chicago Commission on Ventilation. The burden of this article is a plea for adequate and suitable ventilation. The authors strongly advocate a fresh-air supply while sleeping:

"It is hopeful for our future that a rapidly increasing proportion of the people sleep with windows open. Nature assists this habit, for nearly everyone accustomed to sleeping in a draft is unable to sleep well unless the draft be present. It seems to be an instinctive sub-conscious saving trait, but unless we encourage it, it does not persist noticeably during out waking hours. Years ago a popular belief obtained that night air was bad for people. We were apprised of the remarkable discovery that if one kept his windows shut at night, he escaped malaria even in a malarial country. Most emphatically we desire to brand this fallacy, the basis of which, of course, was the malaria bearing mosquito.

"Night air in general is good air. It is the same free outdoor air which has been subjected to the sterilizing influence of the sun and the chemical influence of the plants, still further improved by the physical influence of having had its dust in large part removed by the deposition of its moisture as dew or hoar frost."

Results of study of ventilation phenomena in houses and homes are given as follows:

"1. The effect of the direction of the wind outside is very much influenced in its relation to the currents inside of a house by the local conditions of the adjacent buildings and obstructions and by the house itself.

"2. Air currents as a general rule seek the easiest way in and out of a house.

"3. The more inlets there are open on the side facing the wind the better the ventilation, provided there are openings on the leeward side.

"4. Adequately to ventilate a home requires sufficient inlet and outlet openings.

"5. The efficiency of ventilation increases with any increase in the difference between the temperatures indoors and outdoors.

"6. Better results are usually possible when ventilating the entire house that when ventilating only one room.

"7. Proper distribution of fresh air is more difficult to attain than

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proper volume. Part of a room may receive good ventilation, while other parts are stagnant.

"8. Furniture exerts a material influence on air currents, and conditions may be improved by intelligent placing of the furniture.

"9. Eddies tend to form wherever the air currents are blocked.

"10. The distribution of the air is best obtained by proper distribution of the inlets and outlets.

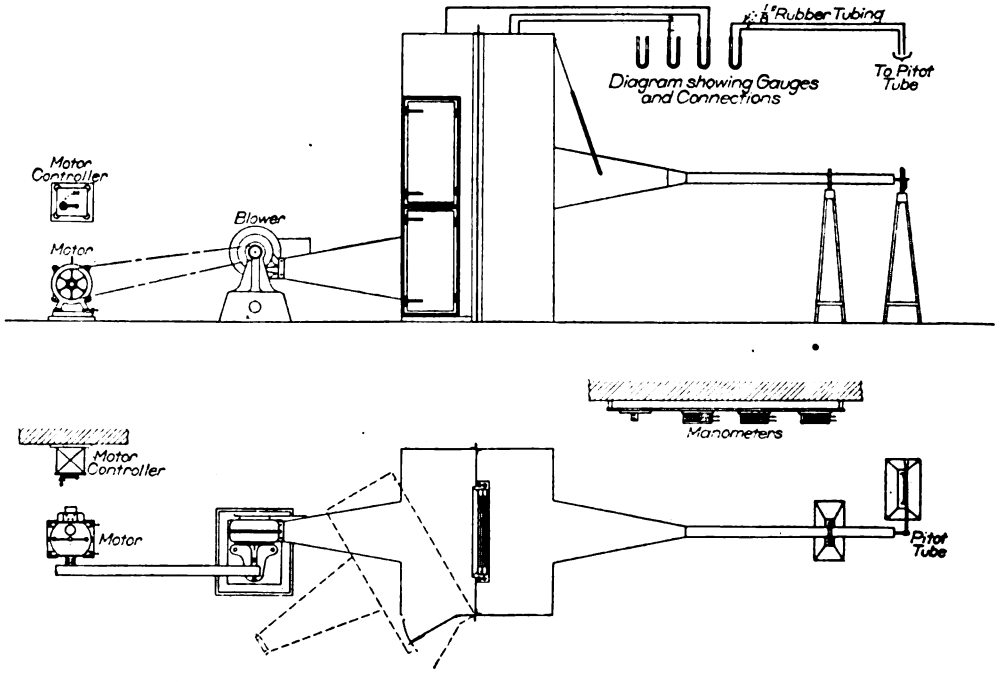
"11. An open stairway tends to cause a current of air to rise through it, even though the windows may be closed.

"12. An open shaft, like a large chimney centrally placed, would assist materially in ventilating a house."

It is urged that radiators be placed in rooms near interior walls; it is then possible to open the windows and obtain fresh air without the direct loss of heat resulting from radiators under the windows.

Electric fans are recommended for a variety of purposes. "The effective way to care for all houses having indirect heaters, such as furnaces, or steam or hot water radiators through which fresh air is passed, is to install electric fans. For instance, a small fan of the ordinary disc type will, if operated in the supply duct leading to such a heater, cause the transmission of about three times the amount of heat from heater to air as will pass by gravity. This insures quick heating in the morning, and the ability, when the house is to be crowded as by an entertainment, to provide by continuous operation of the fan for excellent ventilation. In the house, the fan in the air supply duct would be used intermittently, controlled by a switch on an upper floor."

Other uses for fans are to drive a current of air directly against a radiator and thus obtain better circulation; and to remove odors from the kitchen.



ELEVATION AND PLAN OF APPARATUS FOR TESTING WINDOW LEAKAGE

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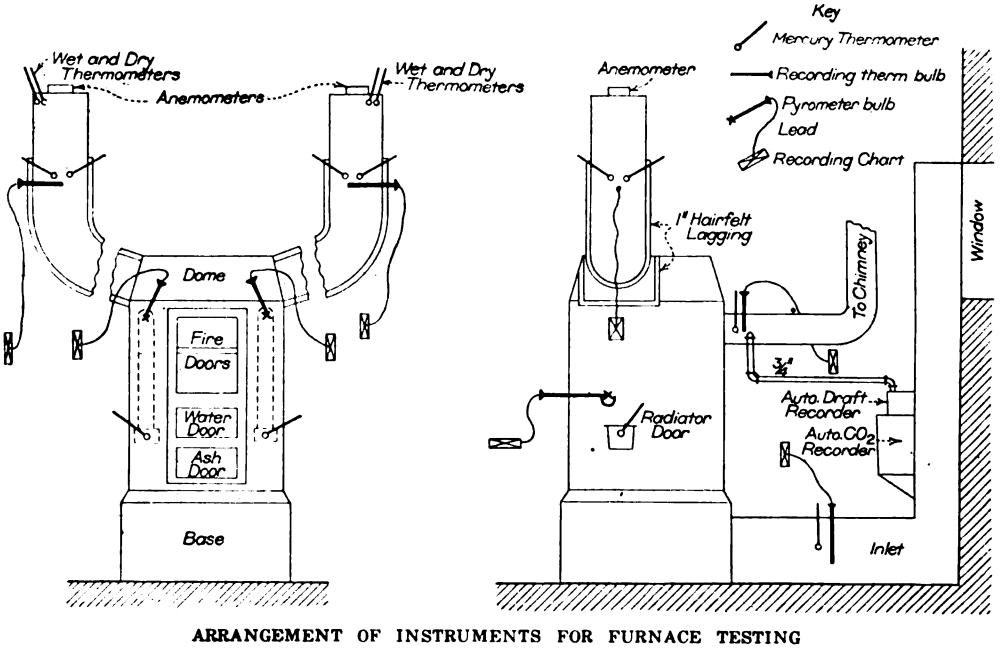
Having found difficulty in calculating the heat losses in large buildings equipped with all-metal windows, because of the unknown factor of window leakage, a firm of architects, McKenzie, Voorhees and Gmelin, instituted a series of experiments on such leakage. Some of the results are described in a paper by Stephen F. Voorhees and Henry C. Meyer, Jr. The tests "extended over a period of some twelve months on different types and different makes of windows, many of the windows being tested under variable conditions. When the tests were started it was supposed that practically all the air leaked through the crack between the sash and the frame and between the meeting rails; that is, it took place around the sash perimeter. It was soon found, however, that there was a very considerable leakage elsewhere than through the crack. The air came through the puttied joints of the glass, and through the connection of the muntin bars, and through the joints of the frame."

The illustration shows the layout of apparatus for conducting the tests. "It consisted of a small Sirocco type of blower belt driven by a variable speed direct current motor. The window to be tested is placed in a partition separating into two parts a chamber made of galvanized iron about 5 feet 5.5 feet in plan and 9.5 feet high, and so constructed as to be practically air-tight. The fan is arranged to discharge into one side of the chamber and from the other side extends a conical galvanized iron pipe terminating in a smaller pipe. A number of differential gauges are employed to record the pressure on each side of the window to be tested so that the differential pressure is obtained. Pitot tubes are employed to test the velocity of air through the discharge pipe mentioned."

It was found that "at a differential pressure of one inch of water the leakage through some of the hollow metal windows amounted to about 10.5 cubic feet per minute, and 1.2 cubic feet with the weather stripped



ARRANGEMENT OF INSTRUMENTS FOR FURNACE TESTING

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wooden window or nearly nine times as much."

In determining the allowances to be made for such leakage when calculating heating requirements, it must be borne in mind that in practice differences in pressure set up on the two sides of a window through the action of the wind tend to equalize by means of the leakage itself and the loss is therefore less. The method, however, is excellent for showing the differences in leakage of different types of window construction.

Heating furnaces have long been vilified by householders as coal-eaters of the deepest dye, approximating the absolute in inefficiency. The rather favorable verdict on their efficiency given by John R. Allen, will therefore come as a surprise to many. Tests on a standard cast-iron heater were made at the University of Michigan. The set-up of the furnace in the testing laboratory and the arrangement of instruments is shown in the illustration.

It was found that the heat absorbed by the air ran from 56.8 to 64.41 per cent of the heat in the fuel. In a typical one of the six tests recorded, the heat thus absorbed by the air was 61.7 per cent; that absorbed by the water in the furnace, 2.41 per cent; the gross given up to the air, 64.11 per cent; that lost up the stack, 16.67 per cent; that lost in unburned fuel, 3.84 per cent; that lost in the surrounding room by radiation, 9.50 per cent; unaccounted for, 5.88 per cent. Based on the heat given up to the air, including that through the water, the efficiency works out 64.11 per cent. If there be credited also the heat lost to the room by radiation and one-half of that unaccounted for, the gross efficiency is 76.55 per cent.

That a room finished in dark green is exceedingly difficult to light efficiently is well enough recognized. Colors differ greatly in their power to reflect and to absorb light. An exact quantitative determination of these differences is now made available by Henry A. Gardner in the January *Journal of the Franklin Institute*. To make a series of tests on a number of colors, "painted samples . . . were first prepared by sizing paper and applying two coats of a number of white and colored paints of which the composition was known. . . . A disk 3¼ inches in diameter, coated with the paint in question, was placed at the centre of an integrating sphere and was illuminated by the light of a concentrated filament lamp shining through an opening in the top of the sphere. The light fell on the disk at an angle of 45 degrees. The interior of the sphere received only such light as had first been reflected by the paint. To effect a standardization a flat block of magnesium carbonate (commercial) was substituted for the disk. The value of the coefficient of reflection of this block was taken as 88 per cent. . . . The readings were made with a portable photometer."

Coefficients of reflection were determined as follows: Light cream, 66 per cent; light pink, 60; light yellow, 58; light blue, 55; light greenish yellow, 54; light buff, 52; light green, 42; light terra-cotta, 41; medium terra-cotta, 39; light greenish blue, 36; medium blue, 32; warm green, 19; medium green, 14; red, 12; dark blue, 12; green, 11.

It was found that flat, semi-gloss and high-gloss paints had about the same illuminating value when prepared of the same pigment mixture with oils or varnishes of the same degree of color. This is important as allowing the use of the type of paint best suited for the lighting equipment of a room.

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ELECTROLYTIC ZINC

COMMERCIAL PRODUCTION BY NEW PROCESS WILL BE IMPORTANT

SPELTER produced by the electrolytic process has been on the market for some time, but the method has not been a commercial factor on this continent until recently. Within the past few months the subject has sprung into great prominence, largely because of the fact that the Anaconda has taken up electrolytic zinc manufacture. At present the Weedon Mining Company at Welland, Ontario, is a producer, as is the Bully Hill mine in California, the latter being owned by the General Electric, while the Consolidated Mining and Smelting Company of Canada is well along with a plant at Trail, British Columbia, which is designed to produce about 12,000 tons of metal a year and the Anaconda after successful experimenting with a plant producing five to ten tons per day has broken ground for a huge installation to cost up to $2,000,000 and produce 35,000 tons per year.

As regards the future development of the art, *The Engineering & Mining Journal* comments as follows:

"The magnitude that it will attain and its effect upon the zinc industry of the world remain for the future to tell, but that it is going to have an early and important influence is not to be doubted."

In competition with the old retort process, the cost factor will be primarily determinant, and the question of cheap power is commonly considered to be the most important element in fixing the cost of production. Next to the question of cost comes the fact that electrolytic zinc is usually of high grade. Thus *The Engineering & Mining Journal* says: "The electrolytic spelter will be of high grade if the metallurgists want to make it so. Brunner, Mond & Co., in England, have for years offered electrolytic spelter guaranteed 99.95 per cent Zn. There is no reason why any electrolytic spelter should not be made as good as that if it is worth while. The control of impurities, including cadmium, is easier than it is in smelting."

Mr. Laist of the Anaconda company, writing to the same publication, describes the Anaconda process thus: "Concentrate is roasted. . . . . so as to produce a calcine containing from 2 to 3 per cent sulphur. . . . The calcine, after cooling, is treated with a solution containing sulphuric acid, which dissolves the zinc and a little of the iron. A small amount of manganese dioxide is added for the purpose of oxidizing the iron, which is then precipitated by means of a small amount of powdered limestone. Any arsenic or antimony is carried down by the precipitated ferric hydroxide. The resulting solution contains nothing but zinc, cadmium and copper, and is separated from the residue by filtration. The residue contains the lead, silver and gold and part of the copper originally present. The solution is treated with metallic zinc to precipitate the copper and cadmium, and is then pumped through a clarifying filter-press into a storage tank, from which it goes to the electrolytic cells. . . . Here the zinc is deposited on aluminum plates.

"The solution from the cells contains sulphuric acid and is used for leaching a fresh charge. The zinc deposits on the aluminum plates are stripped off every 48 hr."

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DRILL CARRIAGES FOR TUNNELING

TWO DEVICES USED ON THE MOUNT ROYAL TUNNEL IN MONTREAL

ONE of the most important tunnels driven in recent years was that through Mount Royal, required to give the Canadian Northern admission to the city of Montreal. It involved many interesting features, including the first important application of a new type of drill. Perhaps its most significant contribution to the advance of tunneling practice, however, was the successful use of drill carriages, probably for the first time in America. These carriages as well as those features of the work which had a bearing on their use are described in the *Engineering Record* by S. P. Brown.

It seems that for the work at first machines were used mounted on horizontal bars, in the usual way, the equipment being carried in and erected by hand. "As the rock became harder and more complex," writes Mr. Brown, "it became imperative to devise some mechanical means of handling the equipment, which had attained a weight of several tons. The common type of European drill carriage . . . was not suitable in the present case. This was principally because the Mount Royal headings, averaging from 50 to 100 per cent larger than the Alpine tunnel headings, broke so much ground that time could not be spared to muck out the heading before setting up the drills. It was, therefore, necessary to devise a drill carriage with a long cantilever arm by which the drilling equipment could be extended ahead over the muck pile in the heading, without any material delay after the blasting was completed.

"In order to bring the carriage near enough the face . . . the track on which the carriage ran was riveted to steel plates . . . After blasting, the muckers cleared this track to within about 25 feet of the face. . . . As soon as this was done the drill carriage was run in, hard up against the muck pile, the cantilever arm carrying the drill bar was extended, and the drill bar jacked into place. The drills were thus always in the heading by the time drillers had the roof and sides barred down and sufficient muck thrown from the face to permit the drill bar to be set. . . . None of the drills was ever dismounted from the bar or disconnected from its manifold. . . .

"Two types of carriages were designed and built. One was very simple, for use in the small 8 x 12-ft. heading. . . . The other . . . also had a muck-handling attachment for transporting the excavated material from the face to cars in the rear."

The use of the carriages considerably speeded up the rate of progress, but no particular advantage in speed was gained by the use of the more elaborate type of apparatus.

The simple carriage, shown in Figure 1, had a cantilever beam 36 feet long, 11 by 11 inches. "At the forward end a special steel casting, similar to a pillow block, was attached to the beam with a vertical swivel so that the drill bar, which was clamped into the casting, might be swung about in a horizontal plane." By swinging it parallel to the beam it was easier to move it in and out of the tunnel.

"The carriage consisted of two cars, each having four wheels brass-bushed to 4-in. axles. These axles were square and fitted into vertical slots in the platforms of the cars with bolts giving about 1 in. play

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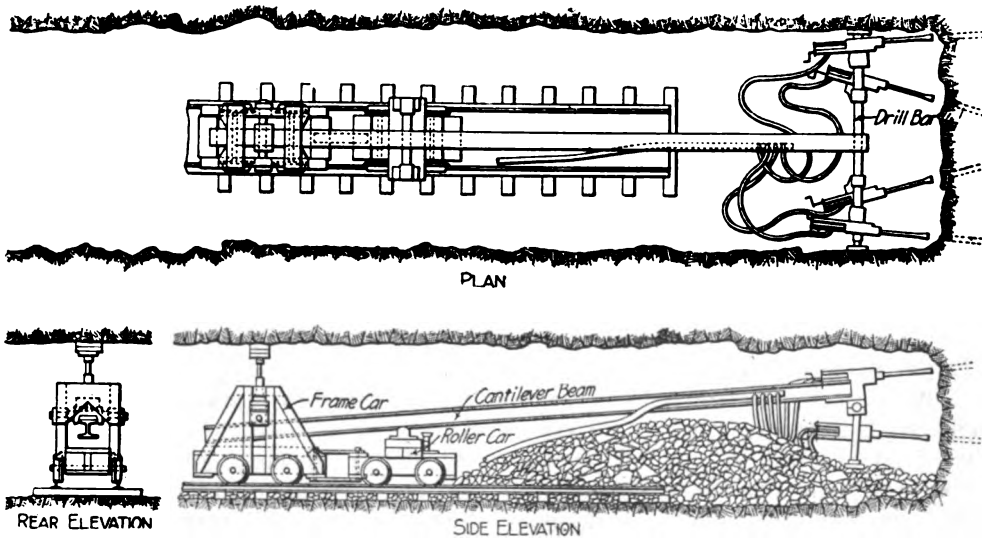
vertically." As a result, all four wheels could stay on the rail and derailments were avoided.

The cantilever beam traveled over an 8-inch steel-faced roller supported on a forward car. In front of the roller was a screw jack with which the beam could be elevated to 4½ feet above the track when fully extended. Behind the roller was a base for another jack with which further elevation could be obtained.

"After the drill bar had been jacked into place a short, vertical jack leg was screwed tight between the bar, close to the beam connection, and the muck pile underneath, to give additional support and rigidity. Next, the roof jack was removed and the carriage drawn back until the rear end of the beam would rise clear of the A-frame. Then the front vertical jack was extended and the beam raised, pivoting around the



SIMPLE DRILL CARRIAGE

A rear car supported an A-frame in which traveled another horizontal roller. The cantilever beam worked under this and by means of a saddle above it, it could be jacked down from the roof and held fast while the cantilever beam was being forced ahead.

"When the carriage was moving out and in, the beam was slid back so that the weight of the drilling equipment was well overbalanced by the weight of the beam behind the forward roller." In adjusting the bar for position in the face, the beam was easily run in and out, while at the same time it permitted sufficient side swing by sliding over the forward roller when pushed by hand.

drill bar until it was close to the roof of the heading. When this was done a gallows frame was set up, consisting of two strong horses, one on each side of the gangway and a 6-inch pipe which spanned the gangway between the horses under the beam. This permitted the passage of muck cars and the usual mucking operations to go on as though no drill carriage had been used, the carriage itself having been hauled back to a siding out of the way."

Figure 2 shows the large piece of apparatus, designed not only to carry the drills to the face but also to load the muck. It was "a very heavy machine, having all of its parts operated mechanically, and was designed

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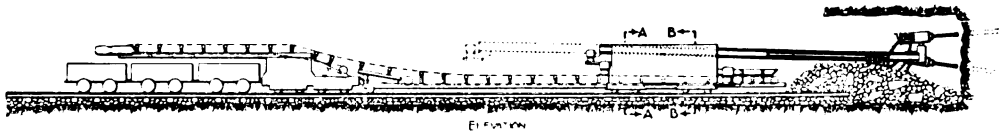
to remain in the heading while the drilling and mucking were going on. The conveying belt, 16 in. wide by 75 ft. between head and tail pulleys, was driven by a Dake air engine. All other power was electrical. The carriage consisted actually of two separate machines or carriages; First, the drill carriage proper, which supported and operated the cantilever arm carrying the drill bar; and second, the muck conveyor, which slipped through the lower part of the drill carriage and was supported a few inches above the track on cross shafts. The belt was elevated in order to cantilever out over three muck cars in the rear.

thus giving the beam its longitudinal motion. The beam was supported in saddles, with rollers, to reduce the friction in its longitudinal motion. . . .

"The saddles supporting the beams were in turn supported on 5-in. threaded shafts at right angles to the longitudinal center line of the carriage. The threaded shafts were rotated in opposite directions by an electric motor at the rear end of the carriage to give the beam its lateral swing. The rear shaft, just described, was fixed in position, but the front one was so arranged that it could be raised and lowered in guides by means of large screw jacks running on ball bearings. These were operated through worm and gear reductions by an electric motor on the front of the carriage, thus giving the beam its vertical swing.



DRILL CARRIAGE AND LOADING MACHINE

"Eight wheels were used on each car or carriage. Four-wheeled trucks, with through axles, could not be used on account of the low position of the belt conveyor. Special trucks were, therefore, designed, by which the two wheels on each side were held in a special steel casting with a king-pin to the frame above, thus giving the necessary flexibility for traveling over curves and switches. . . . Similar trucks were used on the conveyor car. The bodies of both cars or carriages were built of steel plate, heavily reinforced with angles, so that the frames could not warp or twist under the heavy strains to which they were subjected.

"The cantilever arm was similar to that of the simple carriage. At the rear end of the cantilever arm an electric motor was attached, geared to a long threaded shaft running close to the web between the flanges of the I-beam. This thread shaft screwed through a nut that was attached to the frame of the carriage,

"Thus it may be seen that . . . one man at the electric switches was able to extend the beam over the muck pile, raise or lower it, swing it to right or left, as the case might be, to fit the heading as it happened to break. Although this machine appears at first glance to be cumbersome and complicated, it is an interesting fact that breakdowns of any sort were very rare."

As advantages of the larger machine, Mr. Brown notes: Elimination of vibration in the drills due to the large mass behind them; more rapid setting up and tearing down; ability of the muckers to work for some distance along the track; easy shoveling on to the low conveyor; saving in shifting of cars, three at a time being run in by the locomotive to the discharging end of the conveyor.

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WRITING MACHINE OPERATED BY THE VOICE

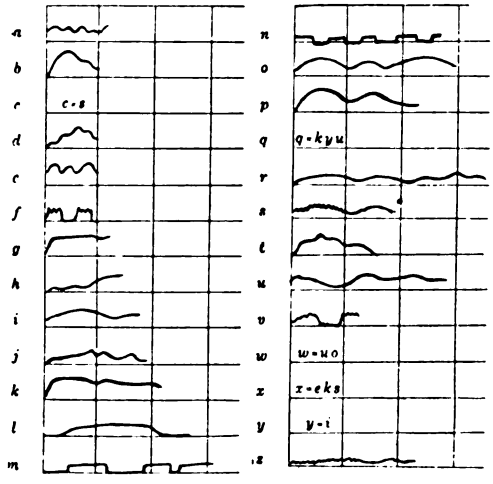
RESEARCH ON NATURE OF SPEECH DISCLOSES PHONOGRAPHIC ALPHABET

DIRECT translation of speech into writing, that is, without the interposition of a human brain, marks an important step in the application of science to life. It is a fascinating achievement and the ingenious research and analysis which led up to it, described by John B. Flower in the *Proceedings of the American Institute of Electrical Engineers*, makes exceedingly interesting reading.

Mr. Flower was first concerned with an investigation of the true nature of speech and proved that: "Speech is a rapid variation in amplitude of one or more tones, there being a definite form of variation making a pattern for each letter sound of the alphabet." The important point in his discovery is that the pattern mentioned is not dependent on pitch. If the series of vibrations corresponding to a certain sound, say a single letter such as *b*, be recorded as a curve, the line connecting the ends of the series of vibrations, will always take a characteristic shape resembling nothing so much as a stenographic symbol.

To determine definitely these patterns for the several letters, Mr. Flower took records of whispered speech, because in whispering the vocal cords are motionless and whispered speech is the same regardless of the character of the voice of the speaker. The records were got by photographing a beam of light from a quartz filament as it was vibrated by the sounds desired. Analyzing these records, the alphabet shown in the drawing was obtained.

"Having shown that speech is made up of a set of pattern pictures of sound waves called the phonographic alphabet, it seemed feasible to design and construct a machine which would record speech automatically in ink on paper in the form of this easily read compact system of natural characters called the phonographic alphabet."



CHARACTERS IN PHONOGRAPHIC ALPHABET

The principles of the machine are somewhat as follows: Talking into a telephone transmitter causes a current to flow through a series of electric resonators. These are variously tuned and that one which is tuned to the main tone of the speech at any instant will respond and vibrate a magnetic strip over its poles. This vibrating strip is mechanically connected to oscillate a mirror. The mirror when stationary directs a ray of light on a blank spot in the middle of a selenium cell so that the cell remains unaffected. As the mirror oscillates, however, it illuminates the cell on the sides of the blank space and so decreases its resistance. A current flowing through the cell is thus varied and an electromagnetic recording pen actuated by the current is caused to trace a wavy line on a revolving platen, this line representing the spoken sounds.

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GREENHEART, A STRUCTURAL TIMBER

WOOD FROM BRITISH GUIANA POSSESSES REMARKABLE QUALITIES

IN spite of its possession of unusual properties which fit it especially for marine work, the timber called greenheart was almost unknown in this country until it was used in the construction of the Panama Canal. It has now been investigated at the Forest Products Laboratory in Madison, Wisconsin, and some of the results of the work there form the basis of an interesting description of the material by A. K. Armstrong in the *Engineering Record.*

Although growing at other points in South America and the West Indies it is now logged only in Demerara, where it thrives along the coast and rivers. The trees attain a height of 60 to 100 feet and a diameter of 2 to 4 feet, but are of very slow growth. The timber is usually hewed for transportation to the coast and shipped in that form. Sawing has been difficult because of a tendency to split, but by special methods this objection has been overcome. Unusual care in seasoning is required to prevent checking and end-splitting. This seasoning consists of storage on a shore where it is submerged by every high tide for a year. The heartwood is greatly superior to the sapwood. The price is high, ranging from $27 to $100 per 1,000 board feet. As for its special qualities, Mr. Armstrong says:

"The unusual properties of greenheart are manifested particularly in its structure, its great weight, its superlative strength and stiffness, its hardness and its great durability. In structure, the unmagnified cross-section has been described as resembling that of cane and palm. . . .

"The specific gravity of the timber is given, by various authorities, as varying between 1.08 and 1.23. . . . On the whole it is heavier than osage orange, the heaviest of the 130 species of American woods tested at this laboratory."

Contrary to previous reports, tests at Madison showed a high content of water and an improvement in strength when dried. The tests "indicate that greenheart, as a beam or post, is 25 per cent stronger and 50 per cent stiffer than black locust, the strongest and stiffest of the 130 species of North American woods so far tested. In resistance to shock it falls considerably below the hickories and classes with beech, birch, ash and oak. It is a tough wood, however. . . .

"Greenheart falls among the hickories in hardness. . . . It is harder to work than oak, planing well, turning hard and badly, polishing indifferently and taking nails badly. . . .

"Greenheart is neither more nor less inflammable than any other timber of the same dry weight per cubic foot. But since it is very heavy, it is remarkably fire-resistant. . . .

"The durability of the heartwood is very great." It "proved highly resistant, and, in most cases, practically immune to all of the fungi used. . . . The sapwood proved far less resistant."

It has been popular abroad for many years and remarkable records of durability are available, especially when used as piles, lock gates, etc., the heartwood being resistant to marine borers. In Demerara it is used around houses, and is especially liked for floors, which last 50 to 75 years without signs of wear.

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MAGNETIC HAND

GERMAN INVENTION TO AID WORKMEN CRIPPLED IN WAR

AN ingenious device designed to compensate somewhat for the loss of the forearm on the part of a workman is described by Professor G. Klingenberg in the *Zeitschrift des Vereines deutscher Ingenieure.*

In its simple form it is shown in Figure 1. A cuff or gauntlet is provided to slip over what remains of the arm. To the end of this a pot- or bell-shaped magnet is attached in such a way that it is not easily removable but is capable of motion in any direction by means of a ball-and-socket joint, and can be clamped fast.

Connection with the electric current can be made with some other part of the body, such as the foot, the chin, the sound arm, the whole body or even by means of the injured arm. The magnet permits taking hold of any iron object, lifting it and moving it as desired. The hand is thus suitable for any man working with iron tools or ferrous materials. No important additions or changes are required in standard tools to make them available for such use.

A file for example, could be held as shown in Figure 1, the magnet sticking fast to the end of the file. To use a plane, an iron plate need only be fastened to the front end. In operating a stamping machine, the magnetic hand would be, if anything, more serviceable than the human hand, since it could grip the smooth surface of the sheets to be stamped. On the lathe, the magnetic hand could manipulate the chisel and the sound hand the support. Tools not of iron would need only the addition of an iron plate to make them susceptible to handling with the new device, such would be the feed levers on machine tools. By varying the size of the magnet, the strength of the grip could be varied as desired.

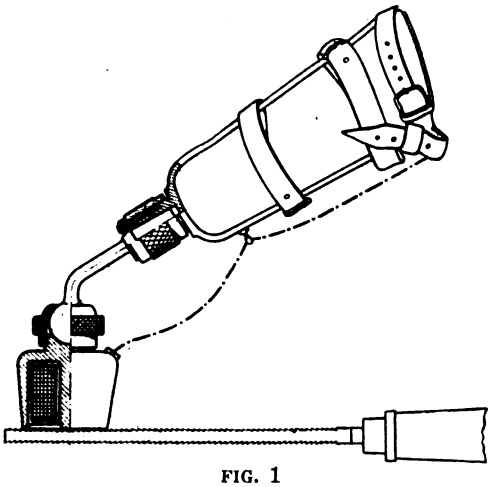

FIG. 1

Figures 2 and 3 show more highly developed application of the idea, namely, to opening-and-closing tools such as pliers and pincers. It is even suggested that the motion between the two parts of the arm could be imitated and also that of the fingers.

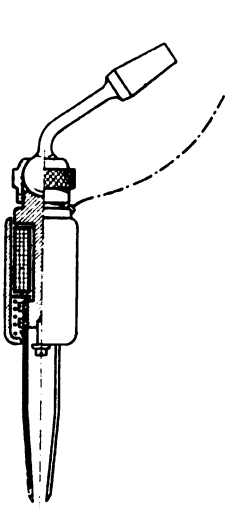

FIG. 2

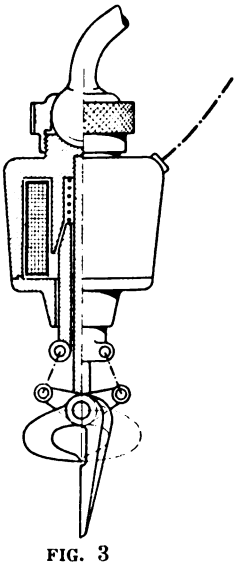

FIG. 3

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NEW FIREDAMP DETECTOR

SIMPLE INSTRUMENT DEVELOPED BY BUREAU OF MINES

INCREASING use of the electric lamp by coal miners, has rendered necessary the development of some instrument for detecting and measuring the methane, or firedamp, present in mine air, a function formerly performed imperfectly

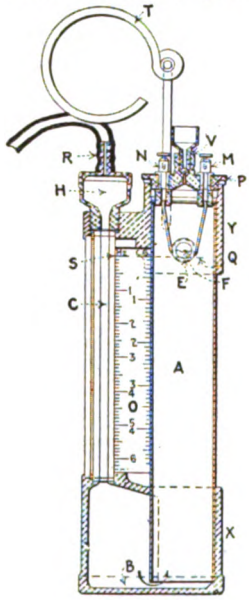

FIG. 1

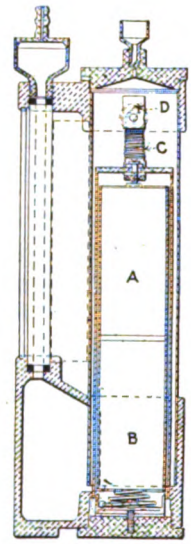

FIG. 2

APPARATUS FOR MEASURING METHANE IN AIR

by the old-style safety lamp. Interest and importance therefore attaches to the device described by George A. Burrell in an address delivered before the West Virginia Coal Mining Institute and reproduced in part in *Coal Age*.

As described in *Coal Age*, the device was "planned so as to derive from a miner's cap lamp or hand-lamp battery the small amount of electrical energy required for its operation. The current is switched from the cap lamp to the gas detector for a space of less than 1½ min., the cap lamp being kept burning."

The device can be used also for detecting natural gas, gasoline vapor, hydrogen, carbon monoxide and other gases, being thus available for purposes outside of coal mining.

It is shown in its most common form in Figure 1, consisting of "seven parts, the aluminum castings *X* and *Y*, the standard brass tubing *A*, the stout gage glass *C*, the aluminum scale *Q*, the brass reservoir *H* and the brass top piece *P*, carrying a platinum wire *F*." In addition are a valve *V* and binding posts *M* and *N*, a small glass window *E* for observing the wire, and the bail *T*.

In operation, water is poured into the tube *A*, until it and *C*, with which it is connected at *B*, are filled to the point *S* in *C*. To make a determination, the operator opens the valve *V* and blows into *H* through the rubber tube attached to *R*. This forces water up in *A* until it clicks at the valve. The rubber tube is then pinched and the instrument held where the test is to be made. Then, when the tube is released, the water falls in *A* and sucks in a supply of air to be tested. The valve is closed and electrical connection made to the lamp battery. The platinum wire heats and burns any combustible gas in the air. This reduces the volume of the air and after shaking to cool the products of combustion, the amount by which the volume is reduced can be measured on the scale. As low a content of methane as 0.1 per cent can thus be detected.

Figure 2 represents a similar device in which two small dry cells *A* and *B* are provided to furnish the energy for heating the wire; this is for use in mines where electric lamps are not available.

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RECENT ELECTRIFICATION PROJECT IN ENGLAND

THIRD-RAIL, DIRECT-CURRENT SUBURBAN LINE OUT OF MANCHESTER

ELECTRIFICATION progress in this country has been closely paralleled by similar development in England. Recent work there includes the first electrification in the Manchester district, a branch of the Lancashire and Yorkshire, extending from Manchester to Bury and equivalent in length to 22 miles of single track. The work was carried out under the general direction of J. A. F. Aspinall, general manager of the railway company; we are indebted to him for the information and the illustrations here presented.

Power requirements entailed the construction of a new generating station, sufficient in capacity to provide for extensions. In this station coal is dumped from cars directly into the bunkers and then chuted to the automatic stokers. The boiler installation includes three Babcock and Wilcox units, each with an evaporation of 32,000 pounds of water per hour, the steam pressure being 200 pounds, superheated to 700 degrees.

Two main generator sets are in service, with a normal capacity of 5,000 kilowatts. The turbines and generators were made by Dick, Kerr and Company.

The 6,600-volt alternating current is transmitted to two sub-stations, stepped down and converted to a 1,200-volt direct current. The contact system for the trains involves a third rail and track return, the latter augmented by a fourth rail between the running rails. The relatively high voltage, 1,200, necessitates extra precaution against shock; to provide for this, a side contact is used between the collecting shoes and the third rail.

The typical train is to consist of five cars, the first, third and last being third-class and carrying motors, the other two, being first-class trailers. Each motor car carries four 200-horsepower motors, mounted two on each truck. A rotary transformer under the car reduces some of the current to 100 volts and this is used for the control mechanism and for lighting. The 1,200-volt circuit drives the motors and is used for heating.

The coaches are strictly all-metal and actually fireproof. They are probably the first cars in the world in which metal has entirely superseded wood for construction. The frame is of steel, the paneling of the sides and roof is made up of aluminum sheets, and the interior finish consists of drawn steel and aluminum sections. The flooring is built up of galvanized sheets and composition sheets are laid on this. The cars are entered at the ends and are provided with passageways down the center. Particular attention is paid to the lighting and heating arrangements. Electric fans are provided either to exhaust foul air or to supply fresh. Sanitary strap hangers are secured to the roofs of the third-class cars for use during rush periods. What seems an unusual feature, is the furnishing of large panorama photographs of places of interest to complete the artistic inside decoration of the cars.

These, we may suppose, are in partial compensation for the absence of announcements of tooth pastes, tobaccos, bread, hosiery and other articles of necessity and luxury with which the eyes of the more favored American traveler are regaled.

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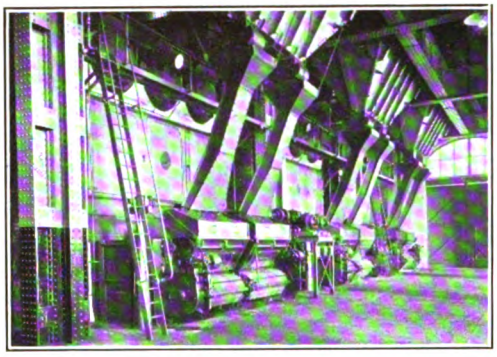
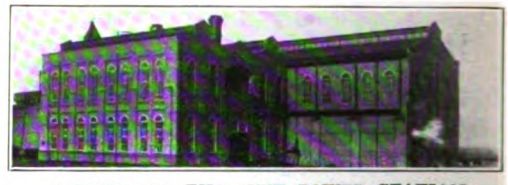
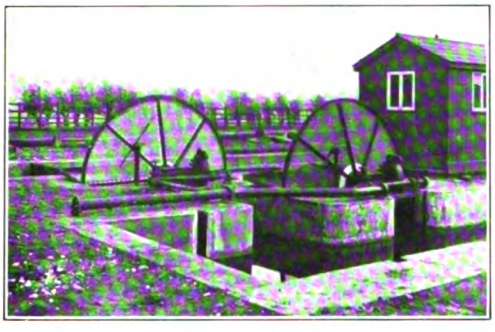


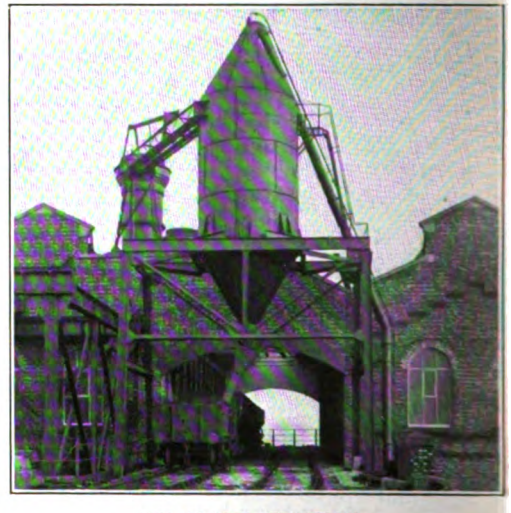
BOILER ROOM
Automatic stokers and coal chutes from bunkers



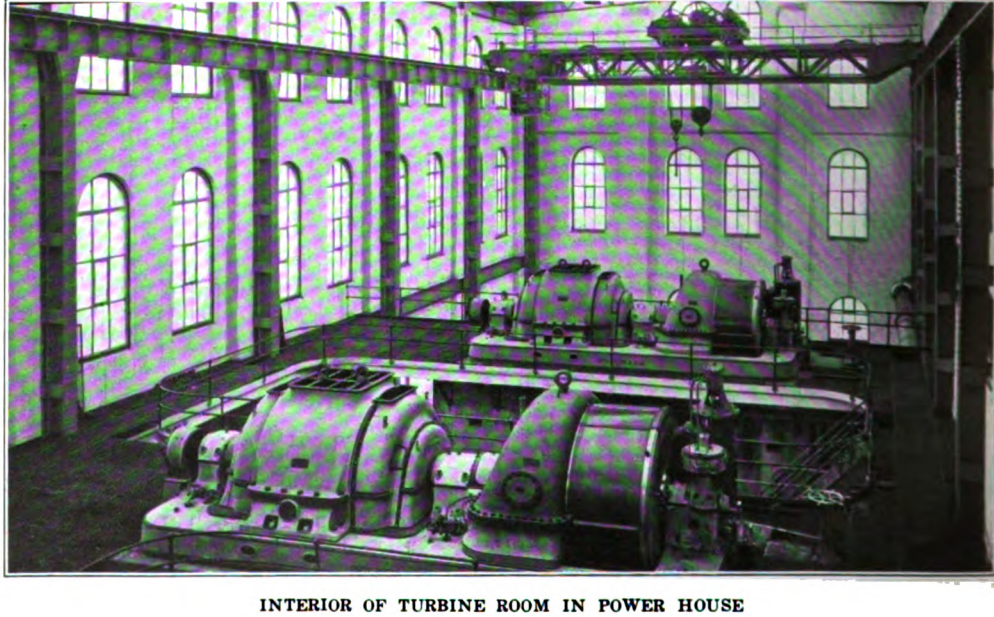
OUTSIDE OF THE NEW POWER STATION



ROTARY SCREENS
For removing debris from feed water



ASH-PLANT RECEIVER
Ashes are conveyed to this by suction system. Chute discharges over either track



INTERIOR OF TURBINE ROOM IN POWER HOUSE
Showing Dick-Kerr machines and overhead crane

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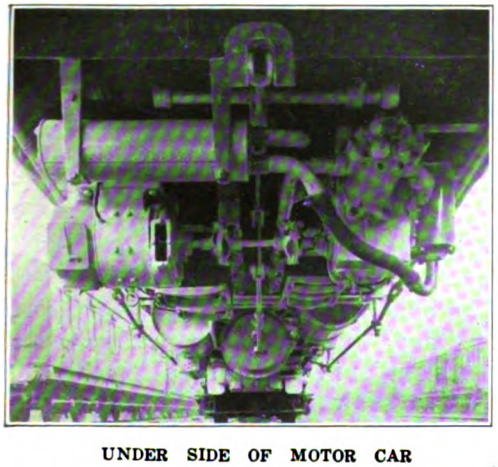
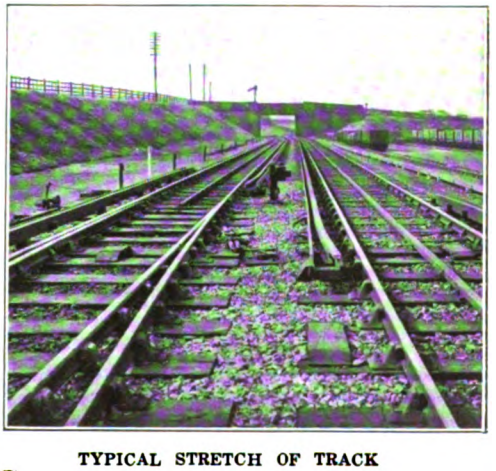
INTERIOR OF THIRD-CLASS COACH

INTERIOR OF FIRST-CLASS COACH

TYPICAL TRAIN OF FIRST- AND THIRD-CLASS CARS



UNDER SIDE OF MOTOR CAR



TYPICAL STRETCH OF TRACK

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ELECTRO-HYDRAULIC SHOVEL

MACHINE USING ELECTRIC POWER APPLIED THROUGH HYDRAULIC PRESSURE

MANIFOLD as are the excellencies of the steam shovel, its deficiencies are almost as pronounced. The attempt to substitute electric power for steam has met with moderate success but the electric shovel has not as yet made great headway. Apparently, however, the problem of a thoroughly satisfactory electric shovel has been solved by Frank H. Armstrong, as described by him in the *Bulletin of the American Institute of Mining Engineers.*

The Penn Iron Mining Company requiring a new shovel for stockpile loading looked into the electric-shovel question but according to Mr. Armstrong, "after considerable study, serious objections suggested themselves to the use of a shovel operated directly by electrical apparatus by reason of the complicated control, severe service on the motors and the heavy surges of current required from the line. It was finally decided to construct an electro-hydraulic shovel using water under pressure to perform all the necessary operations except that of propelling, for which a separate motor was best suited."

The body, boom, dipper and handle of the steam shovel were retained. There were installed in place of the steam equipment a motor-driven centrifugal pump, a pressure tank into which the pump discharged, an air compressor and air tank, water cylinders and plungers and a suction tank into which the cylinders discharged and from which the pump drew its supply. In addition were the control and transmission mechanisms. The air compressor and tank were finally proved unnecessary and were discarded.

Mr. Armstrong describes the operating mechanism of the shovel as follows: "The dipper is hoisted by means of a large cylinder and plunger. The double hoisting ropes pass around two sheaves, at the outer end of the plunger. One end of these ropes is anchored to the front flange of the hoisting cylinder, while the other end is fastened to the dipper. The dipper travels 2 ft. for every foot the plunger travels. The cylinder is single acting, since the weight of the dipper pulls back to the plunger.

"The swinging of the boom is effected by means of a double-acting cylinder with a piston and rod extending through each cylinder head, with a sheave at each end of the rod. The swing circle at the base of the boom is moved by a rope, the middle of which passes around the front end of the swing circle and the ends go around the sheaves on the ends of the rod and fasten to the car body.

"The thrusting is done by the piston rods of four thrusting cylinders directly connected to the dipper handle."

Operation is carried on by one man only, using two hand levers, two foot levers and a button. A solenoid trip is provided for the dipper door, the door being released by pressing the button mentioned, and being closed by gravity. As for capacity, "the average speed of the machine is between three and four dippers a minute." The input power curve shows a variation from 75 kilowatts to 135.

The enumerated advantages of the shovel are: One-man control, absence of high peaks in power requirements, light wear, few moving parts, smooth and accurate control, noiselessness and cleanliness.

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PROHIBITION IN A BOOM GOLD CAMP

OATMAN, ARIZONA, EXPERIENCING A RENAISSANCE UNDER DRY CONDITIONS

TWO phenomena, extraordinary in their nature, held the interest of the Southwest last year; one was the sudden ascension of the state of Arizona to the prohibition wagon; the other was the vigorous revival of interest in the old-time camp of Oatman in Mojave County, following the discovery of unexpected ore deposits in depth. The anomaly of a boom mining camp operating without the usual lubricants has been productive of much comment. In the *Mining and Scientific Press*, Frank H. Probert, an engineer of distinction, has described the revived camp with a discrimination and vividness rather uncharacteristic of his profession. Excerpts from his description follow:

"The automobile stops at the Oasis cafe, the biggest little gold mine in the district, where the pay-streak is always rich and the bullion ready minted. A busy scene is presented, for this is the heart of Oatman, the end of the trail, the meeting-place for everybody. I counted 50 cars within a stone's throw of the Oasis at the noon-hour. The prospector's faithful friend, the burro, is no more; his place has been taken by the equally reliable and faster Ford car.

"The Oasis cafe is the best place to feed, although the Mojave Eats, and the Mulligan, or 'Mad House,' as it has been dubbed, are well patronized, judging by the bread-line outside at 5 o'clock every evening.

"Oatman is a typical boom town of mushroom growth; houses hastily thrown together, lean-tos of all descriptions, stores, banks, booths—but no saloons. Arizona went dry on January 1, 1915. This subject of prohibition must not be dismissed without comment. Its effect on the standard of work, the *moral* of the community, and the deterrent influence it has against viscious practices is most noticeable. The saloons of former days, the bars, foot-rails, display of glassware, white-vested bartenders—all these outward signs remain; and the tendencies, appetites, and habits of mining men of all classes ring true to bygone days, but thirsts are quenched and success toasted with grape-juice high-balls, or malted milk. The result is obvious: the town is orderly, conversation is clean, competition keen, money is saved, a harmless game of pool or billiards serves as recreation after a full day in the field, and the street is deserted before 10 o'clock at night. I am informed that fully 30 per cent of the monthly pay-roll is invested in local mining-stocks, or put into the ground prospecting. There is a contagious, clear, healthy atmosphere.

"Accommodations for the visiting hordes are not of the best, but are improving. Prospect tunnels and the dry arroyos near town are eagerly sought by the wise ones who have brought their blankets. The Oatman Hotel sleeps two and three men in a room and lucky is he who can find private quarters.

"What a motley mixture of humanity, what types are foregathered here! Bankers, brokers, engineers, agents, those of brawn and those of brain, promoters intent on selling something they haven't got to someone who doesn't want it, newspaper men, state senators, pseudo-politicians, horny-handed miners, yellow-legged experts, all sorts and conditions of men, all there for one purpose, all buoyed by the same hope."

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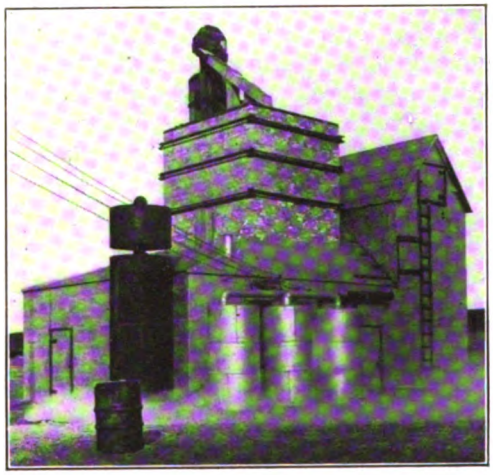
UTILIZATION OF SASKATCHEWAN LIGNITE

VAST DEPOSITS SUITABLE FOR A VARIETY OF PRODUCTS



OUTSIDE OF THE TESTING PLANT

THERE exists in southern Saskatchewan near Estevan an exceedingly large fuel deposit consisting of several seams of lignite, which has as yet been mined and used only on a small scale. In a recently published report, S. M. Darling records the results of an exhaustive investigation which he carried out for the Provincial Government in order to ascertain what would be the most suitable means of commercial exploitation of these valuable beds.

Mr. Darling notes that "these brown coal deposits are of inestimable value to Saskatchewan and Manitoba, for, aside from a small quantity of Tertiary lignite in the Turtle Mountains in Manitoba, and some scattering deposits in the Willow Bunch and Dirt Hills districts west of the Estevan field, they are the only proved source of fuel in the vast territory between the head of the Great Lakes and the Alberta coal fields in the Rocky Mountain region. It is, of course, trite to say that cheap fuel and power are essential to a country's industrial development.

"The tonnage mined annually in Saskatchewan has aggregated about 200,000 tons for several years. Despite the large increase in population the output does not increase." Eastern coals have encroached on the market and the reason for the failure of lignite to hold its own lies in certain of its characteristics. Chief of these are its high content of moisture with consequent tendency to slack, susceptibility to spontaneous combustion, rapid distillation of unconsumed gases and lack of coking qualities resulting in disintegration on the fire and trouble in firing.

Mr. Darling's study looked to the elimination of these undesirable qualities or the use of the fuel in such way that they would not interfere. He covered methods of burning raw, of drying, of briqueting, of burning in powdered form and especially of carbonizing, that is destructive distillation to produce a variety of products with a variety of uses.

These several feasible uses he summarizes as follows: "Dried lignite, for use on automatic stokers and fuel-gas producers, and, when pulveried, as a powdered fuel. Dried lignite briquettes, for use in large, hand-fired furnaces. . . . Carbonized lignite, for use in power-gas producers. . . . Carbonized lignite briquettes. These have proved excellent for domestic service. . . . Gas, which may be sold as a 'town gas,' or utilized for the production of cheap electrical power or for burning clay products. Power, derived from the surplus gas. Byproducts, from the tar and ammonia compounds."

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STAINLESS STEEL

CHROMIUM ALLOY HIGHLY RESISTANT TO CORROSION

SOME interesting information in regard to a steel alloy recently brought out in England was contributed by Sir Robert Hadfield to a meeting of the Faraday Society and has been reproduced in part in *The Iron Age*. The alloy, known as "stainless" steel, is especially characterized by its content of chromium, around 12 per cent. It has thus far been particularly used for the manufacture of cutlery.

The author notes that, "Exaggerated claims were made a few years ago that nickel steel would resist corrosion. No doubt if the metal is present in large percentages the product is more highly resistant but in the end it will also corrode and quite badly. Moreover, as regards ordinary commercial nickel steels of lower percentages, while they show somewhat lower corrosion, it is found that when deterioration once commences corrosion continues at a not much less rate than in ordinary steel."

He also points out that some old experiments of his showed that a steel alloyed with chromium would resist solution in sulphuric acid to a large extent, while some test bars of this alloy recently examined after more than 20 years were still bright and almost free of rust, although no particular pains had been taken in preserving them.

A typical analysis of the new stainless steel shows: Carbon, 0.28 per cent; silicon, 0.01; manganese, 0.12; chromium, 12.7; cobalt, 0.45; iron, 86.6. It "is stated neither to rust nor tarnish in contact with food or acids. It is now making great headway. The author believes that cutlery manufacturers are making use of it on quite a large scale, for, although the cost is considerably more than knives from ordinary steel, it is much superior in its anti-corrosive qualities."

There arises the question regarding wider fields of application for the alloy. The question was brought up of "the value of this high chromium steel as to its practical application, and whether it could be used for parts of dock gates and other purposes, where corrosion is very considerable; and whether it could be produced in the form of plates, angles and other products."

As to this, mechanical tests show that, "The elastic limit and tenacity vary according to the heat treatment. The elastic limit of the forged material is very high, varying from 28 to 33 tons per square inch, breaking load 44 to 50 tons; the elongation is excellent when the material is annealed, being as high as 27 per cent in 2 in., with a reduction in area of 50 per cent. The ball hardness in this case is 185. . . . The material requires considerable care in forging and rolling, but there is no doubt an important opening could be found for this valuable product. . . .

"Rather singular to say, this steel does not show satisfactory corrosion resistance in 10 per cent sulphuric acid solution. The alloy steel containing 10 per cent shows a loss of 18 per cent, and that with 15 per cent chromium a loss of no less than 33 per cent. . . . It would therefore be well, in order to determine whether high-chromium steels are adapted for resisting corrosion—as for instance, that of sea water on parts of dock gates, etc.—that full and proper tests should be first carried out, for example, in sea water and other media."

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ELECTRICALLY HEATED HIGH SCHOOL

BUILDING AT BURLEY, IDAHO, USES CHEAP CURRENT WITH GOOD RESULTS

IDAHO HIGH SCHOOL HEATED BY ELECTRICITY

PROXIMITY to a Government irrigation and power project in the West appears to carry with it many advantages. One of these is the possibility of using, in ways usually not considered feasible, the electric power which the Government sells at low rates. Thus, for example, a new concrete high school in Burley, Idaho, is heated wholly with current furnished by the Minidoka plant of the United States Reclamation Service.

An idea of the size and construction of the school building is afforded by the accompanying photograph, from *The Heating and Ventilating Magazine*. This magazine also notes that the Burley installation is the second of the kind in the region, the high school at Rupert being similarly equipped and served by the same plant.

As described in the *Electrical World*, the building "has a total cubical content of 780,000 cu. ft., although at the present time only two of its three stories are in use and heated. Already this winter the installation has been tested under conditions of outside temperature as low as 7 deg. below zero.

"A total of 752 kilowatts in heaters is installed in the building, but at the present time the maximum demand reaches only about 275 kw. Energy is furnished on a flat rate of $1 per kilowatt per month, based on the maximum service during the month. . . .

"Even the present maximum demand of 275 kw. is seldom taken after 11 a. m. or noon, and in the afternoon the heating load rarely exceeds 135 kw. At the present flat-rate schedule, the heating bill for the year will be about $1,800."

The current enters the building at 2,200 volts and is reduced to 440 for heating at full capacity and to 220 when less than is demanded. The air is heated to 60 degrees by grids automatically controlled, then washed and humidified, and again heated by a second battery of grids. Thermostats in each room control dampers at the several openings from the plenum chamber.

The Heating and Ventilating Magazine notes that the heating is "comparatively more expensive than if coal were used, but several factors enter into the problem to alter conclusions as to total cost. The first is the matter of space. The electric heating plant occupies a comparatively small space in the basement. Another form of heating would require an extra building and smoke stack.

"The life of the equipment here used will be five to eight times the life of a steam plant. Again, the labor required . . . is almost negligible. . . . The absence of coal in the building . . . is especially desirable. . . . The smoke . . . can well be missed. Still another point is that the heat is always ready. During four years . . . at the Minidoka dam the service has not been cut off fifteen minutes at a time."

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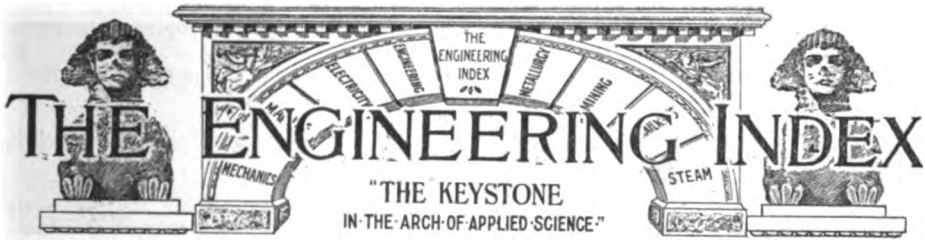

Including a current record of new books.

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☛ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

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CIVIL ENGINEERING

BRIDGES

Approaches

Making the Earthwork Approach to Columbia River Bridge (67581). E. E. Howard. Ills. 3000 w. E N—Jan. 27, 1916. Heavy hydraulic fill at Portland, Ore.

Concrete

Design of the Massachusetts Street Bridge Over the Kansas River at Lawrence, Kansas (67222). Ills. 2500 w. E & C—Jan. 12, 1916. Reinforced concrete arch under construction.

Q Street Bridge at Washington (66994). Ills. 1400 w. E N—Jan. 6, 1916. Ornamental concrete arch.

Falsework

Difficult Falsework Erection for 242-ft. Concrete Arch (67260). Ills. 700 w. E N—Jan. 13, 1916. Use of a Howe truss of round logs to carry centering.

Floors

Broken Track Stringers in Bascule Bridge Lead to Proposed New Floor Design (66917). F. H. Avery. Ills. 1800 w. E R—Jan. 1, 1916.

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Lift

A Bridge Over the Arkansas River Near Pine Bluff (67266). Ills. 1500 w. R A G—Jan. 14, 1916. Combination railroad and highway structure with lift span.

Piers

Caisson-Sinking and Pier Construction at Southwark Bridge (67335 A). Ills. & Plate. 1200 w. Eng—Dec. 31, 1915. Details of work in constructing one of the river piers.

Quebec

Quebec Bridge Erection, Progress in 1915 (66997). H. P. Borden. Ills. 1500 w. E N—Jan. 6, 1916. Completion of north cantilever and entire south anchor arm.

Review of 1915

Bridge Building (67533 A). 1800 w. Enr—Jan. 7, 1916. Progress and completion of important bridges.

Specifications

Die neue Verordnung betr. Eisenbetonbauten der der Aufsicht des Bundes unterstellten Transport-Anstalten (67033 B). Fritz Hübner. 2700 w. S B—Jan. 1, 1916. Serial, 1st Part. Building specifications for reinforced concrete structures in connection with Swiss railroads, especially bridges.

Viaducts

Reinforced Concrete Street Viaduct at Denver, Colo. (67586). Ills. 2500 y. E N—Jan. 27, 1916. Features of a viaduct 8,500 ft. long, designed for heavy loads.

CONSTRUCTION

Buildings

Steel Frame of Printing Crafts Building Designed to Prevent Vibration (67174). Ills. 1000 w. E R—Jan. 8, 1916. Building in New York City.

Coal Dock

Reinforced Concrete Combined with Timber for Coal Pockets and Trestle (67172). Charles F. Dingman. Ills. 1000 w. E R—Jan. 8, 1916. Structure at Poughkeepsie, N. Y.

Concrete

Contractor Handles Electrically Concrete Materials for Huge Chicago Hotel (67084). Ills. 1000 w. E R—Jan. 29, 1916. Plant and methods.

Large Volume of Concrete Handled in Small Batches at Halifax Ocean Terminals (67081). Ills. 3500 w. E R—Jan. 29, 1916. 1,000 yds. a day in ½-yd. batches.

Discussion of Some Special Methods of Reinforced Concrete Design (67443 B). J. R. Worcester, H. B. Andrews and M. J. Lorente. 2000 w. B S C E, Jl—Jan., 1916.

New Features in Concrete Spouting Plant (67100). Ills. 1300 w. E N—Jan. 6, 1916. Field museum building in Chicago.

Engineer Builds Economical Concrete House with Simple Equipment (67312). Ills. 2000 w. C-C A—Jan., 1916. What can be done by one who builds his own residence.

Dams

See same heading under *Water Supply.*

Derricks

Stresses in 50-Ton Steel Derrick Reduced by Elimination of Goosenecks (67558). Ills. 1000 w. E R—Jan. 22, 1916. Details of a cast-steel head which takes the place of goosenecks.

Diary

Construction Engineers' Field and Office Diary (67458). J. C. L. Fish. Ills. 1500 w. E N—Jan. 20, 1916. Systematic plan of keeping diary.

Excavation

Electrically Driven Dragline Scrapers Dig 45-Mile Irrigation Canal (67082). Ills. 2000 w. E R—Jan. 29 1916. Crossing desert on Sun River project.

See also same heading under *Measurement.*

Grain Elevator

Design of a Million-Bushel Public Grain Elevator at New Orleans, La. (67137). Ills. 2000 w. E & C—Jan. 15, 1916. General features.

Grouting

Grouting Under Canal Lock Wall Foundations (67489). Eric P. Muntz. Ills. 1200 w. C n E—Jan. 20, 1916. Work on the new Welland ship canal.

Grubbing

Grubbing a Large Reservoir (67406 D). George A. Winsor. 1000 w. N E W W A, Jl—Dec, 1915. Grubbing Kensico reservoir.

Piers

2,500-Ton Concrete Cribs Are Built and Launched in a "Shipyard" (67292). Ills. 1800 w. E R—Jan. 15, 1916. Methods of work at Victoria, B. C.

Piles

Cleaning Hollow Piles with a 10-In. Orangepeel (66999). G. L. Knight. Ills. 1000 w. E N—Jan. 6, 1916. Miniature bucket used for extracting débris.

Railways

See Construction under RAILWAY ENGINEERING, *Permanent Way and Buildings.*

Reservoirs

Methods of Construction of a Concrete-Lined Oil-Storage Reservoir (67205). 1500 w. W E—Jan., 1916. Near Bakersfield, Calif.

Concrete-Lined Oil-Storage Reservoirs in California: Construction Methods and Cost Data (67601 D). 1200 w. A S C E, Pro—Jan., 1916. Continued discussion of E. D. Cole's paper.

Roofs

Arch-Truss Roof for Drill Hall (67583). Ills. 1100 w. E N—Jan. 27, 1916. Roof of Chicago armory, erected without falsework.

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Sewers
See same heading under *Municipal.*

Specifications
Equitable Specifications and Contracts (67385 A). Hillis F. Hackedorn. Also discussion. 9500 w. A E S Jl—Dec., 1915. Equity and justice in relations between engineers and contractors.

Stadium
Architectural Possibilities of Reinforced Concrete Shown in City College Stadium (66915). Ills. 1500 w. E R—Jan. 1, 1916. Structure in New York City.

Trenching Machinery
Trenching Machinery Used for the Construction of Trenches for Tile Drains (67376 N). D. L. Yarnell. Ills. 26 pp. U S D A—Farmers' Bul 698. Describes types and discusses limiting conditions of work and cost of trenching.

Tunnels
Tunnel Drill Carriages—Their Economic Possibilities (67171). S. P. Brown. Ills. 4000 w. E R—Jan. 8, 1916. First of three articles discussing American and European practice.

Tunnel Lining by Compressed Air Mixing and Placing (67221). Ills. 5000 w. E & C—Jan. 12, 1916. Serial, 1st Part. Method; details of apparatus; examples, etc.

The Astoria Tunnel Under the East River for Gas Distribution in New York City (67600 D). 1500 w. A S C E, Pro—Jan., 1916. Continued discussion of the paper by John Vipond Davies.

Belt Conveyors a Success in Pneumatic Tunnel Construction at Boston, (67077). Ills. 2000 w. E R—Jan. 29, 1916. Haulage system for tunnels driven, lined and concreted in one operation.

Nicholson Tunnel on the Delaware, Lackawanna & Western (67219 A). Ills. 1000 w. R E & M W—Jan., 1916. Construction methods. Brick walls and arched brick roof.

Secure Subway Supports (67595 D). A. B. Lueder and W. J. R. Wilson. Ills. 3500 w. A S C E, Pro—Jan., 1916. Problems met and solved in construction of Sec. 13, Lexington Ave. Subway, N. Y. City.

Four Street Shaft Plants to Handle 300,000 Yards of Excavation in Twelve Months (67085). Ills. 1800 w. E R—Jan. 29, 1916. Subway section in crowded district. New design of plant.

IRRIGATION AND RECLAMATION

Los Angeles
Engineering an Economic Feature of the Irrigation System of the Los Angeles Aqueduct—Construction Just Beginning (67065). Burt A. Heinly. Ills. 4000 w. E & C—Jan. 26, 1916. Distribution pipe line system and irrigation works for extensive project.

Nile
L'utilisation du Nil (67018 C+D). Jean Ott. 28 pp. P C Am—May-June, 1915. Utilization of Nile waters for irrigation.

Relief Gates
Two Relief Gates Considered for Handling Cross-Canal Flood Waters. (66921). Joseph Jensen. Ills. 2000 w. E R—Jan. 1, 1916. Experimental installations to determine type to be adopted.

Trenching Machinery
See same heading under *Construction.*

Water Duty
Notes on the Duty of Water (67478 A). J. W. Beardsley. 2000 w. C C E—Jan., 1916. Area to be developed under given water supply, with special reference to Porto Rico.

MATERIALS OF CONSTRUCTION

Asphalt
Progress in Asphalt Refining; with Notes on Mexican Asphaltic Crudes (67106). Leroy M. Law. Abstract of paper read at Worcester, Mass. 1800 w. Cn E—Jan. 6, 1916. Evolution of refined asphalts.

Cements
Die Verwendung der verschiedenen Zementarten in Kalibergbau (67056 B). A Hoffmann. Ills. 3500 w. Glk—Dec. 25, 1915. Applications of Portland, magnesia and blast-furnace cements in the potash industry.

Concrete Aggregates
Requirements for Acceptance of Concrete Aggregates Based Upon Standard Tests (67175). Ills. 3500 w. E R—Jan. 8, 1916. Methods for continuous sampling and testing of concrete.

Corrosion
The Corrosion of Metals: Ferrous and Non-Ferrous (67249 A). 4000 w. Mch E—Dec. 31, 1915. General discussion at meeting of Faraday Society.

Grading
The Grading Industries (67317). Edward S. Wiard. Ills. 5500 w. M & C E—Jan. 15, 1916. Serial, 1st Part. Mechanical problems in sizing, classifying, etc.

Railroad Materials
Important Work of Bureau of Standards (67420 A). 2500 w. I A—Jan. 20, 1916. Investigating causes of failures and development of improved processes.

Road Materials
See same heading under *Roads and Pavements.*

Stone
See same heading under MINING AND METALLURGY, *Minor Minerals.*

Straining Effects
The Effects of Straining Structural Steel and Wrought Iron (67597 D). Henry S. Prichard. Ills. 11000 w. A S C E, Pro—Jan., 1916. Changes; fatigue formulas and their applications, etc.

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Timber

Report of Committee on Service Tests of Bridge and Structural Timber (67460 N). 8000 w. A W P A—Jan., 1916.

Report of Committee on Specifications for the Purchase and Preservation of Treatable Timber (67459 N). 6500 w. A W P A—Jan., 1916.

Greenheart, Used in Panama Canal, Is a Timber with Exceptional Qualities (67083). A. K. Armstrong. 2500 w. E R—Jan. 29, 1916. Serial, 1st Part. From Demerara, has great strength, costly.

Timber Preservation

Methods of Creosoting Douglas Fir Timber (67463 N). O. P. M. Goss. Ills. 2000 w. A W P A—Jan., 1916. Methods on Pacific Coast; outline of recent development.

Creosoted Piling and Poles (67464 N). Frank W. Cherrington. Ills. 2000 w. A W P A—Jan., 1916. Methods of treatment.

Quantity of Zinc Chloride per Tie or per Cubic Foot of Timber, and Method of Determining the True Strength of the Solution (67461 N). W. F. Goltra. 2000 w. A W P A—Jan., 1916. General discussion of practice.

Wastes

Tremendous Possibilities in the Utilization of Wastes from Long-Leaf Yellow Pine (67488). A. D. Little. From a paper read before the Am. Inst. of Chem. Engrs. 2500 w. M Rd—Jan. 20, 1916. The numerous possible byproducts and their value.

Wood Block

Treated Wood Block for Factory Flooring and Miscellaneous Uses (67468 N). C. H. Teesdale. 2500 w. A W P A—Jan., 1916. Methods of manufacturing and laying; results in service; tabulated reports and records.

MEASUREMENT

Beams

New Formulas and Diagrams Give Deflections of Beams Under Any Loading (67293). Charles A. Ellis. 1000 w. E R—Jan. 15, 1916. Application of area-moment method; diagram for facilitating computations.

Graphical Treatment of Elastic Ribs (67477 A). C. S. Whitney. Ills. 2000 w. C C E—Jan., 1916. Simple method for drawing to scale the elastic curve for any rib or beam under any load.

Reinforced Concrete T Beams (67521 A). E. G. W. Montgomery. Diagrams. 1200 w. S M C E—Jan. 7, 1916. Two methods; examples.

The Design of Reinforced Concrete Tee-Beams (67209). H. Devereux. 600 w. W E—Jan., 1916. Rules and diagram for calculation.

English Measures

The Origin of English Measures of Length (67313 A). Charles M. Watson. 5500 w. R S A—Dec. 31, 1915. Reviews history of development and gradual correlation.

Evaporation

A Study of the Depth of Annual Evaporation from Lake Conchos, Mexico (67603 D). 1500 w. A S C E, Pro—Jan., 1916. Continued discussion of the paper by Edwin Duryea, Jr., and H. L. Haehl.

Excavation

Measurement Methods for Quarry and Open-Cut (67207). C. S. Galbraith. Ills. 2500 w. W E—Jan., 1916. Irregular excavations.

Hydraulic Jump

The Hydraulic Jump, in Open Channel Flow at High Velocity (67602 D). 3500 w. A S C E, Pro—Jan., 1916. Continued discussion of Karl R. Kennison's paper.

Latticed Members

Note sur le flambage des pieces a treillis (67019 B). D. Mathieu. Ills. 1500 w. G C—Dec. 25, 1915. Formulas for buckling of latticed members.

Logarithms

Extended Logarithms (67350 A). Arthur S. Little. 2000 w. Jl Act—Jan., 1916. Serial, 1st part. Explanation of factoring principle, applicable to large numbers.

Oil Flow

Experiments on the Flow of Oil in Pipes (67550 A). Arthur C. Preston. Ills. 8000 w. U C J E—Dec., 1915. Experiments at Univ. of Colo. to obtain information for use in designing oil systems.

Safety Factors

Knickfestigkeit und Sicherheitsgrad (67048 B). Gümbel. Ills. 3000 w. Z V d I—Dec., 25, 1915. Problems in regard to breaking strength and the factor of safety.

Secondary Stresses

Secondary Stresses (67525 A). 3000 w. Eng—Jan. 7, 1916. Editorial review of R. L. Manville's article in *Eng. News*.

Soil Pressures

Experiments on the Distribution of Vertical Pressure Through Sand. (67427). Melvin L. Enger. Ills. 1600 w. E & C—Jan. 19, 1916. Experimental work at the University of Illinois.

Surveying

New Topographic Survey Methods for Rapid Work (66998). James H. Bonner and Frank E. Bonner. Ills. 2500 w. E N—Jan. 6 1916. Changes in methods for timber lands.

MUNICIPAL

Activated Sludge

The Activated Sludge Experiments at Salford (67241 A). W. H. Duckworth. 3500 w. S M C E—Dec. 24, 1915. Results of recent experiments.

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The Activated Sludge Experiments at Salford (67338 A). 3000 w. Enr—Dec. 31, 1915. Review of W. H. Duckworth's paper read before Assn. of Mgrs. of Sewage Disposal Works, dealing with results obtained.

Baths

See Filtration under *Water Supply.*

City Administration

The Administration of European Cities. (67387). Julius Pitzman. Map. 6500 w. A E S Jl—Dec., 1915. Outlines the administration of London, Brussels, Amsterdam, Bremen, Hamburg and Berlin.

City Planning

Urbanisme et la reconstruction des villes detruites au cours de la guerre (67015 N). 55 pp. S I C F Pro-Ver—Nov. 26, 1915. Discussion of paper by G. Courtois.

Fire Protection

Fire Prevention (67393 A). Charles E. Meek. 3500 w. E S P Jl—Dec., 1915. The National Fire Protection Association and what it has accomplished; fire insurance, etc.

Improvements in Philadelphia's Fire Alarm System (67453). Ills. 1200 w. Mun Jl—Jan. 20, 1916. Details of reconstruction.

Indianapolis

How a Contractor is Putting a Stream Underground (67037). Ills. 1600 w. Cnr—Jan. 15, 1916. The covering over of Pogues Run.

Mapping

The Mapping of Canadian Cities (67103). Douglas H. Nelles. Ills. 3500 w. Cn E—Jan. 6, 1916. Serial, 1st Part. Value of large-scale maps.

Model Towns

Morgan Park—A Beautiful Steel-Mill Town (67109 B). Ills. 1800 w. I A—Jan. 6, 1916. Built by Minnesota Steel Co. to house employees of its recently constructed plant.

Refuse Disposal

Experts Testify on Means of Eliminating Odors in Garbage Reduction (66920). 2500 w. E R—Jan. 1, 1916. Suit at Springfield, Mass., brings out opinions in regard to best methods of treating foul gases.

Sanitation

The Destructive Distillation of Faeces (67006 A). J. Menzies. Ill.s 10 pp. I S E Jl—Dec., 1915. Experiments and possibilities.

Kimberley City Sanitary System (67242 A). James Dunn. 3000 w. S M C E—Dec. 24, 1915. Changes effected during past two years.

Sewage Disposal

Disposal of Suspended Matter in Sewage (67332 A). Rudolph Hering. Read before Int. Engng. Cong. 5500 w. S M C E—Dec. 31, 1915. Collection, delivery and sanitary disposal.

Eight Years of Imhoff Tank Design and Operation (66996). Ills. 4500 w. E N—Jan. 6, 1916. Serial, 1st Part. Experience with two-story tanks in Germany and America.

Sewers

I metodi grafici tedeschi per il calcolo della massima portata attribuibile ad una data sezione del collettore di una zona di fognatura in relazione alle pioggie più critiche (67064 B). Felice Poggi. Ills. 2600 w. M T—Dec. 30, 1915. Serial, 1st Part. Discussion of graphic method for determining capacity of sewers to handle run-off from heavy rains.

A Notable Application of Electrically Driven Machinery in Sewer Construction at Salt Lake City, Utah (67138). Bayard W. Mendenhall. Ills. 1500 w. E & C—Jan. 5, 1916. Use of portable substation.

Hydraulic Ejectors for Grit Removal Merit Trial in Sewer Maintenance (67080). John H. Gregory. Ills. 2500 w. E R—Jan. 29, 1916. Tests needed to demonstrate possibilities of method adopted in Seattle.

Rideau River Intercepting Sewer (67278). L. McLaren Hunter. Map. 700 w. Cn E—Jan. 13, 1916. Work at Ottawa.

Main Garrison Creek Storm Overflow Sewer and Extensions, Toronto (67604). R. T. G. Jack. Ills. 4000 w. Cn E—Jan. 27, 1916. Construction; particular reference to Sec. No. 4.

Privately Financed Sewer Systems for Small Town Produces $2,000 Yearly Revenue (67173). Henry W. Taylor. 2200 w. E R—Jan. 8, 1916. Project at Troy, Penna.

Smoke

Smoke Prevention (67040 A). A. L. Nesbit. 14 pp. E C D—Nov., 1915. Work in Pittsburgh, investigation.

Storm Water

Tanks for Temporary Storage of Storm Water (67104). W. G. Cameron. Ills. 1500 w. Cn E—Jan. 6, 1916. Design and methods of construction at Toronto.

Street Cleaning

Street Cleaning and Pavement Economy (67135). Gus H. Hanna. Slightly condensed paper before Worcester Road Cong. 2500 w. Mun Jl—Jan. 6, 1916. Elements of economy.

Machinery in Street Cleaning (67589). 2200 w. Mun Jl—Jan. 27, 1916. Experiments at Milwaukee to determine cost and efficiency.

Streets

Planning Street Alignment (67259). Ills. 1500 w. Mun Jl—Jan. 13, 1916. Importance and economy.

Diagonal Thorofares (67454). Ills. 1400 w. Mun Jl—Jan. 20, 1916. Serial, 1st Part. Advantages. District of Columbia rules.

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Elevation of Low-Level Streets on Pittsburgh River Front (67584). Charles M. Reppert. Ills. 2000 w. E N—Jan. 27, 1916. Raising streets above flood level. New drainage system.

Traffic

How City People Travel (66975 A). Roger W. Toll. Maps. 4500 w. G E R—Jan., 1916. Analysis of traffic conditions in Denver, Colo.

ROADS AND PAVEMENTS

Bituminous

Methods for the Examination of Bituminous Road Materials (67371 N). Prévost Hubbard and Charles S. Reeve. Ills. 48 pp. U S D A, No. 314—Dec. 10, 1915. Details of tests.

Block

A Study of Cushions for Pavements of the Block Type (67428). Maurice B. Greenough. 3000 w. E & C—Jan. 19, 1916. Read before the Am. Assn. for the Adv. of Science. Materials used; problems.

Brick

Recent Advancement in the Construction of Brick Pavements (67066). William C. Perkins. Read before Am. Assn. for Adv. of Sci. 2500 w. E & C—Jan. 26, 1916. Progress with reference to subgrade, cushion course, cushionless construction and brick surface.

Some Radical Changes in Brick-Pavement Construction (67585). P. C. McArdle. Ills. 1800 w. E N—Jan. 27, 1916. Thin concrete foundation advocated.

Columbia Highway

The Columbia River Highway in Oregon (67005). Ills. 2500 w. G R—Jan. 1, 1916. Broad semi-technical description.

Concrete

Proportioning of Concrete for Road Work; Suggestions for Improvement and Obstacles in the Way (67224). W. W. Crosby. 2500 w. E & C—Jan. 12, 1916. Present situation, with suggestions.

Pelham Manor Concrete Road (67193 A). Charles A. Mullen. Ills. 1800 w. Mun E—Jan., 1916. Design and construction; thin bituminous wearing surface.

Construction

Economic Highway Construction; an Analysis of Roadway Sections (67225). F. W. Harris. Ills. 1200 w. E & C—Jan. 12, 1916. Width, location, building through swamps, etc.

Highway Engineers

Enlarged Field for Highway Engineers (67192 A). 1700 w. Mun E—Jan., 1916. Demand for experienced men.

Oiling

Surface Oiling of Earth Roads. (67384 N). B. H. Piepmeier. Ills. 22 pp. Ill State Highway Dept Bul, No 11—Dec. 1, 1915. Outline and suggestions as to best method.

Ontario

Canadian Highways Development; with Notes Regarding Ontario's System (67105). William A. McLean. Abstract of paper read at Worcester, Mass. 3000 w. Cn E—Jan. 6, 1916. Past and present activities.

Road Materials

Road Materials of Texas (67051 N). James P. Nash. Ills. 70 pp. Univ Tex, Bul—Nov. 5, 1915. Methods of testing and results.

Street Cleaning

See same heading under *Municipal.*

Streets

Practical Street Construction (67134). Ills. 3000 w. Mun Jl—Jan. 6, 1916. Serial, 1st Part. Dependable methods.

Wood Block

Report of Committee on Wood Block Paving (67462 N). 2000 w. A W P A—Jan., 1916.

Report on Present Representative Practice of Municipalities Covering Treatment and Installation of Creosoted Wood Block Pavements (67467 N). Frank W. Cherrington. 1000 w. A W P A—Jan., 1916. Tabulated report for leading cities of United States.

Report of Special Committee on Specifications for Preservative for Wood Paving Blocks (67466 N). Ills. 1200 w. A W P A—Jan., 1916. Endorses specification presented by A. W. Dow to the Am. Soc. of Munic. Imp. in Oct., 1915.

Proper Oil for Creosoting Wood Blocks for Paving (67516). P. C. Reilly. Ills. 7000 w. R R—Jan. 22, 1916. Mixtures used, their defects, physical properties, and tests.

WATER SUPPLY

Air Lifts

See same heading under MECHANICAL ENGINEERING, *Hydraulic Machinery.*

Aqueducts

Sanitary Features of Los Angeles Aqueduct (67258). Burt A. Heinly. Ills. 2000 w. Mun Jl—Jan. 13, 1916. Favorable situation, large reservoirs.

Bombay

Bombay Water Supply (67520 A). Ills. 1200 w. S M C E—Jan. 7, 1916. History and increased capacity of works.

Brooklyn

The Brooklyn Water Supply (67405 D). William J. Laase. Also discussion. 2800 w. N E W W A, Jl—Dec., 1915. Driven wells and infiltration galleries.

Catskill

The Present Status of the Catskill Water Supply for New York City (67397 D). J. Waldo Smith. Ills. 700 w. N E W W A, Jl—Dec., 1915.

Dams

Stresses in Masonry Dams (67549 A). N. W. Charde. Diagrams. 2000 w. U C J E—Dec., 1915. Algebraic and graphic solution.

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The Kensico Dam (67527 A). Ills. 2500 w. Enr—Jan. 7, 1916. Details of construction and general information.

Kensico Reservoir (67398 D). Wilson Fitch Smith. Ills. 5000 w. N E W W A, Jl—Dec., 1915. Details of construction and of plant.

Reservoir and Concrete Dam in Glacial Drift (67456). H. J. Langlois. Ills. 2500 w. E N—Jan. 20, 1916. Design and construction of hollow concrete dam at Plattsburg, N. Y.

Analysis of the Failure of an Earth-Fill Dam (67261). Guy Sterling. Ills. 4800 w. E N—Jan. 13, 1916. Hatchtown dam on Sevier River, Utah.

Development

Recent Progress and Tendencies in Municipal Water Supply (67102). John W. Alvord. Abstract of paper read at Int. Cong. 3000 w. Cn E—Jan. 6, 1916. Serial, 1st Part. Reviews development of surface supplies and improvements in rapid sand filtration.

Filtration

A Study of the Behavior of Rapid Sand Filters Subjected to the High-Velocity Method of Washing (67596 D). Joseph W. Ellms and John S. Gettrust. Ills. 6000 w. A S C E, Pro—Jan., 1916. Development of high-velocity method of washing rapid sand or mechanical filters.

Some Experiences in Washing Rapid Sand Filters in New Jersey (67227). Francis E. Daniels. From report of New Jersey State Board of Health. 900 w. E & C—Jan. 12, 1916. Washing gravity filters and pressure filters.

Installation de filtration d'eau á la piscine municipale Ledru-Rollin, á Paris (67050 B). J. Dejust. Ills. 1400 w. G C—Jan. 8, 1916. Filtration for municipal baths in Paris.

See also same heading under MECHANICAL ENGINEERING, *Heating and Cooling*.

France

La Houille Blanche en France et en Allemagne (67016 B). Ernest Coustet. Ills. 2400 w. La Nt—Dec. 25, 1915. Resources of France and Germany in hydraulic power.

Germany

See France.

Ice Troubles

Sicherung des Turbinenbetriebes gegen Eisstörungen (67057 B). L. Koch. 3800 w. Z g T—Dec. 20, 1915. Protection of water-turbine plants against ice.

Intakes

New Quincy Intake Characterized by Provision Against Accumulation of Sand (66916). Ills. 1500 w. E R—Jan. 1, 1916. Line laid in gravelly river bed.

Kansas

Water Supplies of Kansas. Part I. Ground Water Supplies (67655 N). C. A. Haskins and C. C. Young. Ills. 187 pp. Univ Kan Bul—April 1, 1915. Plants, their construction, equipment and operation.

Leaks

The Location of Leaks in Submarine Pipe Lines (67403 D). Elmer G. Hooper. 900 w. N E W W A, Jl—Dec., 1915. Method in New York City on 12-in. crossing; Rikers to North Brothers Island.

Legislation

Water Power Laws and Their Relation to Industry and Progress (67095 A). F. Darlington. Ills. 5500 w. E M—Feb., 1916. Congress will be called upon to modify present laws.

Proposed Legislation Relative to California Ground-Waters (67206). Charles H. Lee. 4000 w. W E—Jan., 1916. Judicial decisions and suggestions.

Mains

Laying Water Pipes in Congested Streets, New York City (67401 D). M. Blatt. Ills. Also short discussion. 2500 w. N E W W A, Jl—Dec., 1915. Conditions and difficulties.

Meters

Testing Meters with Reference to Curves of Accuracy and Friction Loss (67404 D). Fred B. Nelson. 1500 w. N E W W A, Jl—Dec., 1915. Features which need improving.

Pipe Joints

I. Leadite Joints for Water Pipes. Henry A. Symonds. II. Leadite for Joints in Cast-Iron Water Pipes. W. C. Hawley (67407 D). Two papers discussed together. 7500 w. N E W W A, Jl—Dec., 1915. Testimony concerning the use.

Angles, Elbows and Lay-Out Construction by New Method (67607). William J. Smith. Ills. 1200 w. M & E W—Jan. 29 1916. Curve sheet diagram and its use.

Reservoirs

Serbatoio a costante carico di efflusso (67012 B). C. Fossa-Mancini. Ills. 8 pp. S I A I An—Dec. 16, 1915. Serial, 1st Part. Device for maintaining constant head on outflow from reservoirs.

Reservoir Improvements at Castleton (67588). Ills. 1200 w. Mun Jl—Jan. 27, 1916. Details; itemized cost by day labor.

See also Grubbing under *Construction*.

Review of 1915

Water Supply in 1915 (67528 A). 3500 w. Enr—Jan. 7, 1916. Work in Great Britain principally.

Russia

Water Power in Russia (67518 A). P. Gurewitch. Map. 4000 w. Eln—Jan. 7, 1916. Water power resources and their present development.

Salem, Mass.

The Water Supply of Salem, Mass. (67442 B). William S. Johnson. Ills. 6000 w. B S C E, Jl—Jan., 1916. History since 1797, recent works. Also discussion.

San Francisco

Work on Hetch Hetchy Water Project Begins (66918). Ills. 1200 w. E R—Jan. 1, 1916. Preliminary construction.

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Water Supply of the San Francisco-Oakland Metropolitan District (67598 D). 10000 w. A S C E, Pro—Jan., 1916. Continued discussion of H. T. Cory's paper.

South Bend, Ind.

Procedure in Maintenance and Operation of Water Works at South Bend, Indiana (67136). Ills. 6000 w. E & C—Jan. 5, 1916. Artesian supply—100 wells.

Spillway Gates

Swiss Automatic Gates Will Guard Wissota Dam (67078). 1000 w. E R—Jan. 29, 1916. Tip only enough to pass excess water.

Tanks

Inclosing 2,500,000-Gal. Steel Water Tank with Masonry (67457). Ills. 700 w. E N—Jan. 20 1916. Metropolitan Water Works, Boston.

Old and New Water Tanks at Princeton, N. J. (67582). R. W. Becker. Ills. 1500 w. E N—Jan. 27, 1916. Striking changes in design.

Tunneling

Tunnelling for a Water Supply (66966 N). F. E. Rosman. Ills. 800 w. Cw E —Dec., 1915. The Millbrook scheme, S. Aust.

Valves

Electrically Operated Valve Installations and Their Control from a Distance (67400 D). Alfred Williamson. 1000 w. N. E W W A, Jl—Dec., 1915. Details of gates for high-pressure system in Manhattan.

Watersheds

Sanitary Improvement of a Large Watershed (67399 D). George G. Honness. Map. 1200 w. N E W W A, Jl—Dec., 1915. Catskill drainage area.

Water Works

A Discussion of 14 Important Features of Water Works Operation—Montana Regulations Governing Water Service (67228). 4000 w. E & C—Jan. 12, 1916. Essential features of discussion and rules and regulations.

Wood-Stave Pipe

The Use of Concrete for Protecting Wood-Stave Pipe (67208). Kenneth A. Heron. Ills. 1500 w. W E—Jan., 1916. Repairs made in Colorado.

Redwood Stave Pipe for Mining and Power Use (67608). H. B. Worden. Ills. 1000 w. M & E W—Jan. 29, 1916. Advantages.

WATERWAYS AND HARBORS

Barge Canals

How the New York Barge Canal Will Be Operated (67455). William H. Yates. Ills. 4800 w. E N—Jan. 20, 1916. Serial, 1st Part. Capacity and service. Gate machines, valve machines, capstans and concrete lock cabins.

Electricity on the New York State Barge Canal (66973 A). E. W. Pilgrim. Ills. 3000 w. G E R—Jan., 1916. In construction and operation.

Coal Docks

Coal Dock for the Southern at Charleston, S. C. (67269). Ills. 1500 w. R A G—Jan. 14, 1916. Plan and construction.

Halifax

Ocean Terminals Under Construction Expected to Make Halifax an Important Port (67557). Ills. 3000 w. E. R—Jan. 22, 1916. Serial, 1st Part. Proposed harbor works.

New Ocean Terminals at Halifax, N. S. (67101). T. W. J. Lynch. Ills. 1800 w. Cn E—Jan. 6, 1916. Serial, 1st Part. General description.

Industrial Trucks

See same heading under MECHANICAL ENGINEERING, *Automobiles.*

Inland Waterways

The Real Truth About Our Waterways (67256). Joseph E. Ransdell. 4500 w. M Rd—Jan. 13, 1916. Reply to ex-Senator Burton's article in the Jan. issue of *Munsey's Magazine.*

Niagara

Conservation and Preservation at Niagara (67546). 1500 w. W E—Jan., 1916. Abstract of lecture by Francis Shenehon. Effects of water diversions on navigation and other questions.

Panama Canal

Annual Report of the Governor of the Panama Canal (67020 N). Geo. W. Goethals. 62 pp. Aug., 1915. Engineering work and other matters.

Review of 1915

Docks, Harbors and Waterways in 1915 (67530 A). 3000 w. Enr—Jan. 7, 1916. Serial, 1st Part. Some of the works completed and in progress.

Shore Protection

Holland Develops New Types of Shore Protection (67560). Ills. 1000 w. E R —Jan. 22, 1916. Growing use of reinforced concrete. Notes from paper by John W. Thierry.

Shore at Venice, California, Best Protected by Permanent Sea Wall and Low Groins (67176). Ills. 5500 w. E R—Jan. 8, 1916. Report of Leeds and Barnard discussing methods of coast preservation.

Sea Walls of Various Designs Discussed and Compared (67079). Ills. 1200 w. E R—Jan. 29, 1916. Venice, Cal.

Welland Canal

See Grouting under *Construction.*

MISCELLANY

Military

A Retrospect (67531 A). 5500 w. Enr—Jan. 7, 1916. Editorial review of the work of engineers in connection with the war.

Review of 1915

Review of the Year (66914). 14500 w. E R—Jan. 1, 1916. Editorial.

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ELECTRICAL ENGINEERING

COMMUNICATION

Cable Bug

The Cable Bug and Its Ravages in Southern California (67184). Albert Schuler. Ills. 2000 w. T E—Jan. 8, 1916. A beetle which bores holes in lead sheathing.

Radiotelegraphy

Electrical Constants of Compound Antennas (67305). A. F. Puchstein. 700 w. El W—Jan. 15, 1916. Method for frequency where capacity and inductance are not uniformly distributed.

Standardization

What Standardization Means to the Operating Companies (67301). W. H. Hay. Read before U. S. Ind. Tel. Assn. Maps. 2000 w. Tly—Jan. 15, 1916. Importance of standards and conditions corrected.

Underground Cables

Underground Cable on the Pennsylvania Railroad (67232 A). Ills. 2500 w. R G—Dec. 24, 1915. Details of construction and factors leading to adoption of type in use.

ELECTRO-CHEMISTRY

Ammonia

The Production of Ammonia from Cyanamid (67316). W. S. Landis. Read before Am. Inst. of Chem. Engrs. 4000 w. M & C E—Jan. 15, 1916. Details of process and plant, with costs.

Electrolytic Processes

A New Electrolytic Cell for Making Pure Oxygen and Hydrogen (67319). Ills. 2500 w. M & C E—Jan. 15, 1916. Details of the I. O. C. bipolar generator and its operation and efficiency.

Electrolysis

Earth Resistance and Its Relation to Electrolysis of Underground Structures (67370 N). Burton McCollum and K. H. Logan. 45 pp. U S B S, No 26—Dec. 20, 1915. Importance of soil resistivity, giving results of measurements and methods of protection.

Electrolysis and Its Mitigation (67346 N). E. B. Rosa and Burton McCollum. Ills. 140 pp. U S B S, No 52—Dec. 27, 1915. Principally a discussion of the prevention of electrolysis in metallic structures, with conclusions as to available methods.

Electroplating

Chemical Analyses of Electroplaters (67357). W. H. Weber. 1500 w. B W—Jan., 1916. Enabling electroplaters to equip laboratory and analyse all plating solutions.

ELECTRO-PHYSICS

Continuous Current

Éléments de circuits a courant continu ou a flux continu en parallèle. Application a un mode particulier de production de courant continu dans les arbres de dynamos. Machines a poles conséquents. Extension aux moteurs d'induction (67014 D). Paul Girault. Ills. 29 pp. S I E Bul—Nov., 1915. Elements of circuits with continuous current or continuous parallel flux, mathematically treated. Applications to dynamos, consequent poles and induction motors.

Impulse Currents

Outline of Theory of Impulse Currents (67480 D). Charles P. Steinmetz. 20 pp. A I E E, Pro—Jan., 1916. All types of currents derived as special cases of intergration constants.

Rays

The Production and Utilization of Roentgen Rays (67509 A). J. S. Shearer. 2000 w. S Jl E—Jan., 1916. Reviews development.

Discussion on "The Measurement of Dielectric Losses with the Cathode Ray Tube." Deer Park, Md., July 2, 1915. (67481 D). 6500 w. A I E E, Pro—Jan., 1916. John P. Minton's article.

Thermo-Electricity

La thermo-électricité des aciers spéciaux (67017 C+D). Eugene L. Dupuy et Albert M. Portevin. Ills. 23 pp. R Met—Aug., 1915. Experiments on thermo-electric phenomena of steel alloys.

GENERATING STATIONS

Building Plants

Conway Building Power Plant (67320). Thomas Wilson. Ills. 2500 w. Pwr—Jan. 18, 1916. Serial, 1st Part. A 1,200-kw. direct-current office-building plant.

Central Stations

Rejuvenation of the Power Plant of United Illuminating Co. (67213). J. Breslav. Ills. 1500 w. Pwr—Jan. 11, 1916. Difficulties overcome at New Haven, Conn.

China

Electric Generating Stations in China (67389 N). C. A. Middleton Smith. Also discussion. 5500 w. I E E—Jan., 1916. Conditions, development, and outlook.

Hydro-Electric

Description of a Hydro-Electric Plant in Brazil (67476 A). T. H. Olds. Map and Ills. 3500 w. C C E—Jan., 1916. Latest and best practice.

Kakabeka Falls Power Development (66927). Frank C. Perkins . Ills. 1500 w. N E—Jan., 1916. Development in Ontario.

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Five Schemes Considered for Power Development at Kananaskis Falls, Alberta (67291). Harold S. Johnston. Ills. 3000 w. E R—Jan. 15, 1916. Serial, 1st Part. Several schemes analyzed. Reason for plan adopted.

Tacoma Hydro-Electric Power Plant (66922). W. L. Kidston. Ills. 2000 w. Pwr—Jan. 4, 1916. Details of municipal plant.

The Lake Margaret Hydro-Electric Power Works (67524 A). Ills. and plate. 3500 w. Eng—Jan. 7, 1916. Serial, 1st Part. In Tasmania, for mines, railways, etc.

Ice Troubles

See same heading under CIVIL ENGINEERING, *Water Supply.*

Parallel Operation

Parallel Operation Troubles (67215). H. E. Ford. Diagrams. 900 w. Pwr—Jan. 11, 1916. Means to overcome tendency of turbo-generator to take all the load from reciprocating engine.

Rates

Discussion on "Rates and Rate Making," New York, Oct. 8, 1915 (67486 D). 20500 w. A I E E, Pro—Jan., 1916. Paul M. Lincoln's paper.

Discussion on "The Best Control of Public Utilities," San Francisco. Cal., Jan. 22, 1915, and "Class Rates for Light and Power Systems or Territories," Deer Park, Md., July 2, 1915 (67485 D). 6500 w. A I E E, Pro—Jan., 1916. Papers by Frank G. Baum.

Reconstruction

Enlarging Important Steam Station Under Load (67503). Ills. 3500 w. El W—Jan. 22, 1916. Changes in Connellsville, Pa., station due to growing load.

Storage Batteries

Standby Battery for A. C. Distribution Service (67071). J. Lester Woodbridge. Ills. 2500 w. El W—Jan. 29, 1916. Use in suburban substation.

Switching

The Design of Power-Station and Substation Bus Structures (67304). Ills. 1200 w. El W—Jan. 15 1916. Laying out and installing switching apparatus.

GENERATORS AND MOTORS

Elevator Motors

Characteristics of the High Resistance Rotor, Squirrel-Cage Motor for Elevator Service and a Comparison with the Phase-Wound Rotor Machine (66976 A). R. H. McLain. 3300 w. G E R—Jan., 1916. Better driving unit for certain types.

Induction Motors

Induction Motors (67279). Ills. 1500 w. P E, C—Jan. 15, 1916. General construction; details.

Losses

Pole-Face Losses (67390 N). F. W. Carter. Ills. 1000 w. I E E—Jan., 1915. Calculations of Eddy-current loss in pole-shoes of dynamo-electric machines.

Motor Applications

The Electric Motor as an Economic Factor in Industrial Life (66974 A). David B. Rushmore. 5000 w. G E R—Jan., 1916. Applications, types, characteristics.

Motor Maintenance

Direct-Current Motor Maintenance (67323 A). S. Lees. Ills. 2200 w. El R—Dec. 31, 1915. Serial, 1st part. Cleanliness; insulation troubles and other causes of failure.

Cost of Motor Repairs (66902). George A. Schneider. 1500 w. El R & W E—Jan. 1, 1916. Details of work.

Surges

A Study of the Surges Caused on Switching Off Asynchronous Motors (67326 A). Reinhold Rudenberg. Abstract from *Elektro. Zeit.* 1000 w. Eln—Dec. 31, 1915. Cause of surges and the remedy.

Turbo-Generator

1250 Kilowatt D. C. Turbo-Generator (67341 A). Ills. 1500 w. Enr—Dec. 31, 1915. Recent addition to power plant of chemical works at Middlewich.

ILLUMINATION

Gas-Filled Lamps

Campo e methodi di applicazione delle lampade a tungsteno in gas inerte (67013 B). Guido Peri. Ills. 2400 w. Ind—Dec. 19, 1915. Serial, 1st Part. Characteristics and applications of gas-filled incandescent lamps.

Incandescent Lamps

Incandescent Lamp Progress (67202). R. W. Shenton. 700 w. El A—Jan., 1916. New developments during 1915.

Reflection

The Light-Reflecting Values of White and Colored Paints (67450 B). Henry A. Gardner. Ills. 1500 w. F I Jl—Jan., 1916. Effect on illumination, tests of a series of colors.

Streets

Street Lighting by White Flame Arc Lamps (67203). Ben Perris. Diagrams. 1500 w. El A—Jan., 1916. The advantages.

Tungsten

The Melting-Point of Tungsten (67230 A). Irving Langmuir, in *Phys. Rev.* 600 w. Eln—Dec. 24, 1915. Values determined by three methods.

MEASUREMENT

Dynamos

The Predetermination of the Performance of Dynamo-Electric Machinery (67552 N). Miles Walker. Ills. 10800 w. I E E—Jan., 1916. Outlines a method applicable to all types.

Meters

Inrichting en werkingswijze van een moderne meterafdeeling bij een electriciteits-bedrijf (67000 B). A. F. E. Hanson. Ills. 7500 w. Ing—Dec. 18, 1915. Methods of adjusting and handling meters in Electra Works, Amsterdam.

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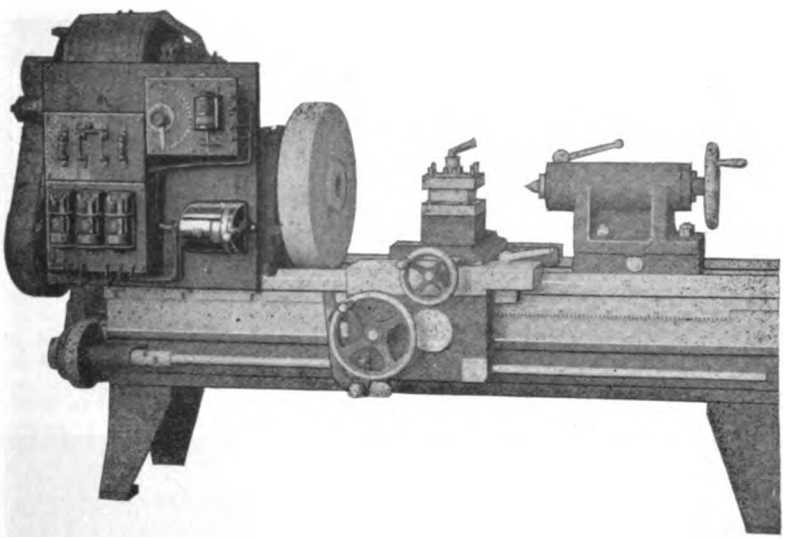

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Discussion on "The Induction Watt-Hour Meter," Deer Park, Md., July 2, 1915 (67484D). 3500 w. A I E E, Pro—Jan., 1916. V. L. Hollister's paper.

POWER APPLICATIONS

See also ELECTRO-CHEMISTRY and MECHANICAL ENGINEERING, *Power and Transmission.*

Bells

Bell Troubles (66929). H. M. Phillips. 1200 w. N E—Jan., 1916. Serial, 1st Part. Faults and remedies.

Brick Making

Electricity in Brick Manufacturing Plants (67146). Ills. 2500 w. El R & W E—Jan. 8, 1916. Process and operating data.

Cooking

Discussion on "Economic Operation of Electric Ovens," Deer Park, Md., July 2, 1915 (67482 D). 1200 w. A I E E, Pro—Jan., 1916. Percy Wilcox Gumaer's paper.

Crane Plant

Electrical Construction at Crane Plant, Chicago (67501). Ills. 2000 w. El R & W E—Jan. 22, 1916. Details of a recent installation.

Garages

Electric Motors in Garages and Automobile Service Stations (66963). Bernard Lester. Ills. 1200 w. El Jl—Jan., 1916. Rapid and efficient repair work.

Gas Comparison

Gas and Electricity for Motive Power (67333 A). W. A. Tookey. 1400 w. S M C E—Dec. 31, 1915. Costs.

Gear Making

Electricity in the Manufacture of Gears (67500). Ills. 3500 w. El R & W E—Jan. 22, 1916. Motor drive in two large plants; tabulated data.

Heating

Electric Heating: Its Present Position and Future Development (67229 A). George Wilkinson. Abstract of paper before Inst. of Elec. Engrs., at Edinburgh. Ills. Also discussion. 2500 w. Eln—Dec. 24, 1915. Advantages of thermostatically controlled heaters.

Electric Heating for a Large High School (67352). Ills. 1000 w. H & V M—Jan., 1916. Details of plant at Burley, Idaho.

Knife Manufacture

Electricity in the Manufacture of the Pocket Knife (66978 A). F. A. Buttrick. Ills. 1500 w. G E R—Jan., 1916. Details of work and apparatus used.

Maintenance

Electrical Maintenance Methods in a Great Office Building (67504). Ills. 1500 w. El W—Jan. 22, 1916. Methods in Equitable Building, N. Y. City.

Paint Making

Electricity in Paint Manufacturing (67285). Ills. 2000 w. El R & W E—Jan. 15, 1916. Advantages of electric drive; typical installation.

Ovens

Der elektrische Kachelofen (System Schoop) (67044 B). D. Korda. Ills. 2500 w. E Z—Nov.-Dec., 1915. Design of electrically heated ovens covered by Schoop process.

Textile Mills

Electric Service in a Cotton-Duck Mill (67070). Ills. 1800 w. El W—Jan. 29, 1916. Power and lighting equipment of mill at Woodberry, Md.

TRANSFORMERS

Design

The Mathematical Design of Transformers (67388 N). David Robertson. Ills. 8500 w. I E E—Jan. 1916. Data required; assumptions; symbols, and method.

High-Voltage

Experiments with High-Voltage Transformer (66900). C. H. Thordarson. Ills. 2000 w. El R & W E—Jan. 1, 1916. Results with aluminum coil, paper-insulated transformer.

Losses

Stromverdrängung (Wirbelstromverluste) im Transformatorenkupfer (67053 B). F. Niethammer. Ills. 1000 w. E u M—Dec. 19, 1915. Eddy losses in transformer copper.

Million-Volt

A Sixty-Cycle Million-Volt Transformer (67294). 1300 w. S A—Jan. 15, 1916. Employed in research work at San Francisco.

Phase Angle

Discussion on "Phase Angle of Current Transformers" and "Calibration of Current Transformers by Means of Mutual Inductances," Deer Park, Md., July 2, 1915 (67483 D). 5500 w. A I E E, Pro—Jan., 1916. Papers by Chester L. Dawes and by Charles Fortescue.

Standardization

The Commercial Standardization of Instrument Transformers (67150). Otto A. Knopp. Ills. 700 w. El W—Jan. 8, 1916. Establishing independent current-ratio standard without laboratory facilities.

Wiring

Transformer Wiring Practice (66901). Terrell Croft. Ills. 3000 w. El R & W E—Jan. 1, 1916. Methods and precautions.

TRANSMISSION AND DISTRIBUTION

Busbars

Busbar Data for Outdoor Switching Structures (67149). C. A. Mees. 1500 w. El W—Jan. 8, 1916. Structural and electrical characteristics of materials, using data in designing.

Hotels

Electrical Construction Features of Hotel Morrison, Chicago (67286). Ills. 3000 w. El W—Jan. 15, 1916. Wiring for light, power, and telephone and signaling.

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Inside Construction

Modern Electrical Inside Construction (67200). B. Gross. Ills. 2800 w. El A—Jan., 1916. Recent installations.

Insulators

Extra High-Tension Insulators (66965 N). W. Wilson. Ills. 1800 w. Cw E—Dec., 1915. Their care.

Some Characteristics of Link Type Insulators (67551 A). L. R. Leonard. 600 w. U C J E—Dec., 1915. Results of recent tests at Univ. of Colo.

Office Buildings

Electric Service in Largest Office Building (67303). R. D. Ward. Ills. 2000 w. El W—Jan. 15, 1916. Methods of distributing energy in this New York building.

Wiring

Outside Wiring (67147). Terrell Croft. Ills. 4000 w. El R & W E—Jan. 8, 1916. Suggestions.

MISCELLANY

Reviews of 1915

Developments in the Electrical Industry During 1915 (66972 A). John Liston. Ills. 7000 w. G E R—Jan., 1916. Summary of year's progress.

Technical and Engineering Progress (66906). Ills. 12000 w. El W—Jan. 1, 1916. Reviews by prominent writers; tendencies in science and applied engineering.

The Year in the Electrical Industry (66897). 9500 w. El R & W E—Jan. 1, 1916. Steady growth rather than remarkable development.

Electrical Engineering in 1915 (67529 A). 4000 w. Enr—Jan. 7, 1916. Serial, 1st Part.

March of Electrical Progress in 1915 (67201). Theodore Dwight. 2000 w. El A—Jan., 1916. Applications of special interest.

Electrical Affairs in Great Britain in 1915 (66898). Albert H. Bridge. 1500 w. El R & W E—Jan. 1, 1916. Effects of war.

Western Electric

Western Electric Developments in 1915 (66903). 2000 w. El R & W E—Jan. 1, 1916. Résumé of company's more important improvements.

Westinghouse

Westinghouse Electric Developments in 1915 (66904). 4500 w. El R & W E—Jan. 1, 1916. Progress.

INDUSTRIAL ECONOMY

EDUCATION

Apprenticeship

Training Mechanical Apprentices at the Norfolk Navy Yard (67098 A). N. E. Adamson, Jr. Ills. 2500 w. E M—Feb., 1916. Report of gratifying success.

Colliery Managers

Training of Colliery Managers (67247 A). Noah T. Williams. Read before the Nat. Assn. of Col. Mgrs. Also discussion. 3000 w. I & C T R—Dec. 24, 1915. Schemes of training.

Co-Operative Courses

How Co-operative Courses Train Young Engineers (67262). H. A. Stringfellow. 1200 w. E N—Jan. 13, 1916. Experiences of part school and part practice methods installed in the University of Rochester.

Engineering

By-Products of an Engineering Education (67542). Armin Elmendorf. 2200 w. W E—Jan., 1916. Broader outlook.

Trade Instruction

The Making of a Skilled Mechanic (67113 B). Ills. 3000 w. I A—Jan. 6, 1916. Methods at Wentworth Institute, Boston.

Universities

The Universities and the Industries (67025 N). 7500 w. Jl I E C—Jan., 1916. Series of addresses by Maclaurin, Talbot, Walker, Little.

FINANCE AND COST

Accounting

Accountancy, Economy and Efficiency in a City Department (67351 A). Harold D. Force. 2500 w. Jl Act—Jan., 1916. Outline of work, and results.

Coal Land Valuation

Evaluating Coal Properties in Western Canada (67133). R. W. Coulthard. 3000 w. C M Jl—Jan. 1, 1916. Essentials which determine value.

Contract Estimating

Estimating Hints for the Contractor (67069). George W. Hill. 1700 w. El R & W E—Jan. 29, 1916. System of records for compiling data.

Cost Accounting

Logical Factory Costs (67096 A). W. E. McHenry. 3500 w. E M—Feb., 1916. Urges adoption of more rational basis of distribution.

Depreciation

Depreciation (67569 N). 36 pp. Util Mag—Jan., 1916. Depreciation Defined. Frederic P. Stearns. Court Decisions on Depreciation. J. H. Goetz. Depreciation and Its Relation to the Fair Value. Halford Erikson. With discussions by James E. Allison, John Bauer. Harry Barker, and others.

Depreciation and Valuation (67349 A). John J. Thomas. 3500 w. Jl Act—Jan., 1916. Principles and problems.

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Inventories

The Making and Maintenance of Priced Inventories of Public Utilities (67573 N). Charles L. Pillsbury. 11 pp. Util Mag—Jan., 1916. With discussions by James W. Phillips, F. W. Ballard, and R. J. Meigs.

Power Plants

Record System for Office Building Plant (66924). 1000 w. Pwr—Jan. 4, 1916. Record and cost-accounting system.

Public Utility Valuation

Valuation of Los Angeles Distributing System (67502). 4000 w. El W—Jan. 22, 1916. Reviews the report of the So. Calif. Edison Co.

Review of 1915

Finance, Commerce, and Public Policy (66905). 8000 w. El W—Jan. 1, 1916. Survey of electrical industry for 1915, including contributions from well-known authors.

Sewer Construction

Method of Keeping a Graphic Cost-Progress Record on Sewer Construction (67429). W. A. Bennett. 1000 w. E & C—Jan. 19, 1916. Chart and explanation of method.

Unit Prices

Unit Prices (67571 N). M. G. Glaeser. 4500 w. Util Mag—Jan., 1916. Their importance; what they include; how they shall be determined.

Valuation

Financial Aspects of Valuation (67572 N). Paul A. Sinsheimer. Also Financial Aspects of Regulation. Robert C. Wood. 6000 w. Util Mag—Jan., 1916. Inflated costs; need for control of credit; need of regulating prices, etc.

Valuation by Approximation (67574 N). John G. Morse. 9 pp. Util Mag—Jan., 1916. With discussions by Alexander Potter, Morris Llewellyn Cooke, Walter N. Polakov, and others.

Valuation and the Future of Public Utilities (67577 N). Milo R. Maltbie. 4000 w. Util Mag—Jan., 1916.

The Meaning of the Constitutional Protection in Valuation (67576 N). Charles A. Prouty. Also article by William D. Kerr. 13 pp. Util Mag—Jan., 1916. With discussions by Newton D. Baker and A. L. Valentine.

Franchise Values (67567 N). 19 pp. Principles as to Franchise Values. Dr. Delos F. Wilcox. Determining Franchise Values. Henry DeForest Baldwin. With discussions by Chester A. McLain, Alfred Bettman and Harry Barker.

Going Value (67570 N). 24 pp. Util Mag—Jan., 1916. Introductory Remarks. Morris Schaff. Going Value as an Element of Fair Value. Clifford Thorne. With discussions by Joseph L. Bristow, A. M. Fox, William J. Hagenah, and others.

Land Values (67568 N). 23 pp. Util Mag—Jan., 1916. Principles to be Applied in Valuing Land. Hammond V. Hayes. Discussions by Thomas D. O'Brien, Edward W. Doty, A. E. Helm, John M. Eshleman, F. W. Stevens, Dr. Milo R. Maltbie, and others.

Original Cost (67566 N). 31 pp. Util Mag—Jan.. 1916. How to Get Rid of the Reproduction Cost Theory. George W. Anderson. Original Cost as the Chief Basis for Fair Value. Dr. Edward W. Bemis. Original Cost. Halford Erickson. Constitutionality of Historical Cost Method of Public Utility Valuation. Alfred Bettman. With discussions by Dr. Robert H. Whitten, Edward P. Burch, and others.

The Reproduction Theory (67565 N). 22 pp. Util Mag—Jan., 1916. Criticism of Reproduction Theory of Valuation. John M. Eshleman. Reproduction Value vs. Fair Value. H. Findlay French. With discussions by Morris Knowles, Halbert P. Gillette, A. B. du Pont, James E. Allison and John M. Eshleman.

MANAGEMENT

Motion Study

Chronocyclegraph Motion Devices for Measuring Achievement (67564 N). Frank B. Gilbreth, and L. M. Gilbreth. 4500 w. 2nd Pan Am Cong—Jan 3, 1916. Utilization of the human element; standardization of motions; device for measuring achievement.

Stock Department

Checking Losses in the Storeroom (67579). Wilfred G. Astle. 3000 w. I T R—Jan. 27 1916. "Balance of stores" system; advantages.

REGULATION

Public Utilities

Leonard Metcalf Suggests Improvements in Public Utility Control and Valuation (67559). 2500 w. E R—Jan. 22, 1916. From presidential address before New England Waterworks Assn.

Railroads

Some Problems and Principles of Government Regulation of Railroads (67144). Emory R. Johnson. From paper before Pan-Am. Sci. Cong. 2500 w. R A G—Jan. 7, 1916. Particularly experience and needs of United States.

Water Power

The Peoples Interest in Water-Power Resources (67378 N). George Otis Smith. 3000 w. U S G S, Water Supply paper 400-A—Jan. 10, 1916. Government regulation and protection.

Water Supplies

Control of Public Water Supplies by the Conservation Commission of the State of New York (67402 D). Russell Suter. Also discussion. 6500 w. N E W W A Jl—Dec., 1915. Work accomplished and future possibilities.

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WELFARE AND SAFETY

Carnegie Steel
Features of Welfare Work at Duquesne, Pa. (67417 A). Ills. 1500 w. I A—Jan. 20, 1916. Children's playgrounds, apprentice school, etc.

Chains
Chains and Other Lifting Gear (67328 A). G. S. Taylor. 3500 w. Qry—Jan., 1916. Causes, and means of preventing, accidents.

Cripples
See Magnetic Hand under MECHANICAL ENGINEERING, *Miscellany*.

Electrical
"Safety First" Between Telephone and Power Wires (67302). F. W. Tenney. 2000 w. Tly—Jan. 15, 1916. What California rules are intended to prevent.

Elevator Accidents
Elevator Accidents and Their Causes (67067). F. G. Nugent. 2000 w. Sf E—Jan., 1916. Points requiring attention.

Gasoline
Hazards in Handling Gasoline (67374 N). George A. Burrell. 3000 w. U S B M—Tech paper 127. Precautions needed.

Lightning Protection
Protection of Life and Property Against Lightning (67347 N). O. S. Peters. Ills. 125 pp. U S B S, No. 56—Dec. 15, 1915. Information encouraging use of rods.

Public Utilities
Some Hazards and Safety Suggestions in Connection with Construction, Inspection and Maintenance of Public Utilities (67032 N). H. W. Mowery. Ills. 20 pp. Am Museum Safety—Jan., 1916.

Quarrying
Quarry Accidents in the United States During the Calendar Year 1914 (67375 N). Albert H. Fay. 40 pp. U S B M—Tech. paper 128. Statistics.

Railways
The Safety Appliances Inspector's Report (67298). 2500 w. R R—Jan. 15, 1916. Serial, 1st part. From report of Chief Inspector Belknap to the Interstate Commerce Commission.

Workmen's Compensation
Compensation Legislation of 1914 and 1915 (67381 N). 390 pp. U S Dept Lab, No. 185—Oct., 1915. Analysis of principal features of laws, and related information.

MISCELLANY

Engineer's Status
The Broader Duties of the Engineer (67386 A). J. C. Ralston. 4500 w. A E S Jl—Dec., 1915. Past and present achievements and future outlook.

The Future of the Engineering Profession (67548 A). Elliott H. Whitlock and Albert J. Hines. 8500 w. C E S Jl—Jan., 1916. Discussion of inter-relations of engineering and technical societies. Also general discussion.

Expert Testimony
Expert (or Opinion) Testimony in Rate Valuation Cases (67575 N). John H. Gray. 12 pp. Util Mag—Jan. 1916.

Exporting
A United States United for Trade in Foreign Lands (67142). Walter S. Hiatt. 4000 w. R A G—Jan. 7, 1916. Importance of organization for export business.

Foreign Investment
American Engineers Enter the Foreign Field (67092 A). Ills. 3500 w. E M—Feb., 1916. Outlines the plans of the Am. International Corporation for promoting American trade.

Germany
What of German Industrial Conditions (67561 A). C. A. Tupper. Ills. 2500 w. I A—Jan. 27, 1916. Effects of war on various industries. Lessons to be learned by America.

Industrial Preparedness
Taking a Census of Industry for Preparedness (67556). 1000 w. E R—Jan. 22, 1916. Editorial on the President's request that engineers make an industrial census of the United States.

Industrial Lessons from the German War Machine (67091 A). C. E. Knoeppel. 5500 w. E M—Feb., 1916. Study of accomplishments of German military leaders during last eighteen months.

Mathematics of War
Il problema tecnico matematico della guerra attuale e l'Italia (67063 B). G. Belluzzo. Ills. 4500 w. M T—Dec. 20, 1915. Mathematical formulas and curves applicable to the war.

Merchant Marine
The Imperative Need for Ships Owned by Americans (67090 A). William C. Redfield. 3000 w. E M—Feb., 1916. Facts in regard to shipping situation of the day.

MARINE AND NAVAL ENGINEERING

Backing Trials
How Ships Act on Backing Trials (66932). Henry Penton. Diagrams. 1500 w. M Rv—Jan., 1916. Observations on trials under numerous varying conditions.

Boilers
Caldaie a intensa produzione di vapore (67062 C + D). Leonardo Fea. Ills. 19 pp. R M—Dec., 1915. Steam production by intensified means, devices including surface combustion.

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The Preservation of Marine Boilers (66993 A). Thomas J. Rogers. 4000 w. I Mr E—Jan., 1916. Suggestions for care.

Boiler Explosion on the S. S. "Bernicia" (67235 A). Also editorial. Ills. 3500 w. Mch E—Dec. 24, 1915. Board of Trade report.

Colliers

Coastwise Collier Jonancy (66987 A). Ills. 500 w. I Mr E—Jan., 1916. Tenth of fleet of 17.

Designing

The Drafting Room (66988 A). H. C. Robinson. 1500 w. I Mr E—Jan., 1916. High-priced drafting often gives low-cost production.

Diesel Engines

The Werkspoor Marine Diesel Engine (66990 A). J. Rendell Wilson. Ills. 2200 w. I Mr E—Jan., 1916. Type installed in twenty-two sea-going commercial ships.

Diving Apparatus

Diving and Diving Apparatus (67330 A). Ills. 1600 w. M E & N A—Jan., 1916. Apparatus and work of divers.

Dry Docks

G. T. P. Dry Dock at Prince Rupert, B. C. (67277). Ills. 1800 w. Cn E—Jan. 13, 1916. Terminal for Pacific Coast shipping.

Pearl Harbor Dry Dock (67599 D). 2500 w. A S C E, Pro—Jan., 1916. Continued discussion of H. R. Stanford's paper.

Propulsion

The Geared Turbine and the Turbo-Electric Systems of Marine Propulsion (66986 A). John H. Macalpine. Ills. 5000 w. I Mr E—Jan., 1916. Trials of collier Neptune compared with performance of sister ship.

Electric Propulsion on a Merchant Vessel (66989 A). Ills. 1200 w. I Mr E—Jan., 1916. Ljunstrom turbo-electric machinery installed on Swedish coastwise merchant steamer.

Salvage

The Refloating of the Hendonhall (66992 A). Robert G. Skerrett. Ills. 1000 w. I Mr E—Jan., 1916. Salving with compressed air.

Shafts

How to Preserve and Protect Propeller Shafts (67329 A). A. J. Lebeda. Read before Inst. of Marine Engrs. Ills. 1200 w. M E & N A—Jan., 1916. Preventing corrosion and reducing friction. Appliances in use.

Aligning the Propelling Shafting of Ships (66896 A). N. I. Mosher. Ills. 1500 w. Mch—Jan., 1916. Establishing centers.

MECHANICAL ENGINEERING

AERONAUTICS

Aeroplane Engines

The 120-H. P. Beardmore Austro-Daimler Aero Engine (67021). Ills. 400 w. A A—Jan. 10, 1916. Brief description.

Aeroplanes

Sloane Tractor Biplane Type "H-1" (67004). Ills. 300 w. A A—Jan. 3, 1916. Brief description.

Stable Biplane Arrangements (67523 A). Jerome C. Hunsaker. Diagrams. 2000 w. Eng—Jan 7, 1916. Serial, 1st part. Research at wind tunnel of Mass. Inst. of Technology.

Aeroplane Wings

Aeroplane Wings (67059). Neil MacCoull. Ills. 600 w. A A—Jan. 24, 1916. Serial, 1st part. Design..

Military

The Fokker Monoplane (67028). Ills. 600 w. A A—Jan. 17, 1916. General description.

Radius of Action

Aeroplani e dirigibili di grande raggio d'azione (67061 C + D). A. Guidoni. Ills. 14 pp. R M—Dec., 1915. Mathematical discussion of factors affecting radius of action of flying machines.

Review of 1915

Aeronautics (67534 A). 2500 w. Enr—Jan. 7, 1916. General outline of progress.

Wind Tunnels

U. S. Naval Experimental Wind Tunnel (67027). Ills. 600 w. A A—Jan. 17, 1916. Brief description.

Two Wireless Sets for Use on Aeroplanes (67022). Ills. 1000 w. A A—Jan. 10, 1916. Brief description of principal features.

AUTOMOBILES

Brakes

Working Out the Rolls Royce Brake (67587). Charles J. Booth. Ills. 2500 w. Aut—Jan. 27, 1916. Experiments with materials led to adoption of asbestos as most satisfactory.

Designing

Light Weight as an Ideal in the Designing of Large Cars (67424). 4500 w. Aut—Jan. 20, 1916. Possibilities for light car construction.

Electrical Equipment

Mechanical Applications of Generators and Motors (66960). W. A. Dick. Ills. 1500 w. El Jl—Jan., 1916. Features to secure good results.

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Lighting and Starting Systems from the Car Manufacturer's Standpoint (66948) 4000 w. El Jl—Jan., 1916. Solution of voltage, storage battery, starting motor, etc.

Control Switches for Electrical Equipment of Gas-Driven Automobiles (66961). B. D. Kunkle. Ills. 1600 w. El Jl—Jan., 1916. Arrangement of control units.

Regulation of Automobile Lighting Generators (66959). C. E. Wilson, Diagrams. 2500 w. El Jl—Jan.. 1916. Types used and systems of regulation.

One-Unit Starting and Lighting Automobile Equipments (66957). H. F. Patten. 2500 w. Types, performance, applications, limitations, points governing selection.

The Application of Electric Starting and Lighting to the Ford Car (66962). W. O. Lum. Ills. 1200 w. El Jl—Jan., 1916. Problem and solution.

Electric Vehicles

Electric Efficiency Improved (67422). Ills. 6000 w. Aut—Jan. 20, 1916. Improvements in 1916 models.

Electric Passenger Cars (66950). Gail Reed. 4000 w. El Jl—Jan., 1916. Development, present high standard.

Electric-Vehicle Practice of Large Brewery (66899). Ills. 3000 w. El R & W E—Jan. 1, 1916. Growing fleet and model garage in Detroit.

Industrial Trucks

Motor Trucks as the Solution of the Marine Freight Terminal Problem (66991 A). Merrill C. Horine. Ills. 2200 w. I Mr E—Jan., 1916. Economy possible.

Ignition

Methods of Ignition (66964). J. B. Dyer. Ills. 2500 w. El Jl—Jan., 1916. Improvements in developing ignition system.

Storing and Releasing Energy (66958) R. P. Jackson. Ills. 1500 w. El Jl—Jan., 1916. Mechanical analogies to battery ignition.

Italian Industry

Italian Trade Profits by War (67423). W. F. Bradley. Ills. 2500 w. Aut—Jan. 20, 1916. Serial, 2nd part. Prosperous automobile and truck conditions.

Motor Trucks

Motor Trucks for 1916 (67369 A). Ills. 40 pp. C V—Jan. 15 1916. Construction, standardization, efficiency, with specifications of 408 American gasoline commercial vehicle chassis.

Prospects

Die Aussichten für die Motorenindustrie nach dem Kriege (67041 B). K. Bilau. Ills. 1800 w. Au-R—Nov., 1915. Prospects for automobile development after the war.

Rectifiers

The Field of Mechanical Rectifiers (66949). A. L. Atherton. Ills. 2500 w. El Jl—Jan., 1916. Details of Westinghouse vibrating rectifier.

The Mercury Arc Rectifier for Charging Electrical Vehicle Batteries (66955). Q. A. Brackett. Ills. 2000 w. El Jl—Jan., 1916. Details of types and explanation of advantages.

Russian Industry

Condition and Development of the Automobile Industry in Russia (67421). Nicolas Kouznetzoff. 2000 w. Aut—Jan. 20, 1916. Development since 1907.

Storage Batteries

Battery Charging Equipment (66954). T. H. Schoepf and A. M. Candy. Ills. 7000 w. El Jl—Jan., 1916. Types, methods of charging, characteristics, etc.

Charging Edison Storage Batteries (66953). E. J. Ross, Jr. Ills. 1200 w. El Jl—Jan., 1916. Details of methods.

Operating Characteristics of Lead Acid Storage Batteries (66951). J. H. Tracy. 2500 w. El Jl—Jan., 1916. Permissible rates of discharge and behavior of batteries.

Small Motor-Generator Sets for Charging Starting, Lighting, and Ignition Batteries (66956). H. A. Campe. Ills. 800 w. El Jl—Jan., 1916. Details and suggestions.

Tractors

The Trackless Train (66952). G. W. Bulley. Ills. 3500 w. El Jl—Jan., 1916. Industrial tractors, control, operating costs.

COMBUSTION MOTORS

Diesel Engines

The Diesel Engine (67510 A). E. A. Garrett. Ills. 1200 w. S Jl E—Jan., 1916. Noteworthy American type.

Experience with the Diesel Engine in the Municipal Power Plant of Palo Alto, Calif (67226). Ills. 3000 w. E & C—Jan. 12. 1916. Read before League of Calif. Munic.

See also same heading under MARINE AND NAVAL ENGINEERING

Gas Producers

Gas Producers and Gaseous Fuels (67039 A). H. F. Smith. 22 pp. E C D—Nov., 1915. Discussion of status.

Oil Engines

Hot-bulb Crude-oil Engines (67410 A). E. M. Rose. Ills. 1200 w. Mch W—Jan. 7, 1916. Serial, 1st part. Designs and operation.

HEATING AND COOLING

Calcium

Calcium (67197 A). J. D. Burby. Read at W. Ice Mfr. Con. 3000 w. I & R—Jan., 1916. Process and cost of manufacturing calcium in refrigerating plants.

Distribution System

Cost of Removing and Replacing Pavements Incident to the Installing of Heating Lines in City Streets (67368 D). W. F. Verner. 700 w. A S H V E Jl—Jan., 1916. Tabulated results of a study.

Electric Heating

See Heating under ELECTRICAL ENGINEERING, *Power Applications*.

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Equitable Building
Heating and Ventilating Plant, Equitable Building (67364 D). W. H. Driscoll. Ills. 2000 w. A S H V E Jl—Jan., 1916. Detailed description.

Filtration
The Filtration and Softening of Water (67198 A). T. G. Windes, Jr. Read before the W. Ice Mfrs. Con. 2500 w. I & R—Jan., 1916. Methods, purification, water-softening systems.

Furnaces
Some Elements of Smokeless Furnace Design (67353). Osborn Monnett. Ills. 2200 w. H & V M—Jan., 1916. Settings may be improved.

Gas Heating
Gas House Heating (67547 A). Ills. 10000 w. C E S Jl—Jan. 1916. Records of actual consumption of natural gas in some 47 homes or apartments. General discussion.

Hot-Air Furnaces
Heat Analysis of a Hot-Air Furnace (67361 D). John R. Allen. Ills. 2000 w. A S H V E Jl—Jan., 1916. Tests.

Ice Making
Latest Developments of Fresh Water Ice (67199 A). C. G. Osborne. Ills. 3000 w. I & R—Jan., 1916. Four systems considered; characteristics, advantages and field of each.

The Manufacture of Ice by the Raw Water Process (67196 A). George B. Bright. Read at W. Ice Mfrs. Con. 3000 w. I & R—Jan., 1916. Cost, design, operation, etc.

Laboratories
A Notable Institution for the Advancement of the Heating and Ventilating Art (67359 A). Arthur K. Ohmes. Ills. 2500 w. A S H V E Jl—Jan., 1916. Testing Institute for Heating and Ventilation appliances at Berlin University; equipment and plant.

Light and Heat
Modern Systems of Independent Lighting and Heating (67355 A). Ills. 1800 w. Nt—Jan. 6, 1916. Oil, oil gas, and petrol-air gas systems.

Office Buildings
Heating a Chicago Office Building (67366 D). S. Morgan Bushnell. Ills. 2500 w. A S H V E Jl—Jan. 1916. Relation between theoretical calculations and actual results.

Operating Cost
The Cost of Operating Heating Plants (67367 D). George W. Martin. 2500 w. A S H V E Jl—Jan., 1916. Records of plants in New York covering last five years.

Radiators
Determination of Radiator Sizes for Hot Water Heating Plants (67354 A). Freywid Wegelius. 600 w. H & V M—Jan., 1916. Based on rule applying to series of temperatures.

Refrigeration
Steam-Jet Refrigeration (67216). J. C. Bertsch. Ills. 1600 w. Pwr—Jan. 11, 1916. From paper before Am. Warehouse Assn. Westinghouse-Leblanc system.

Vacuum Heating
Atmospheric, Vacuo-Vapor and Vacuum Heating Systems (67322). James D. Hoffman. Ills. 1300 w. Pwr—Jan. 18, 1916. Compares relative advantages.

Ventilation
Can We Standardize the Requirements for Ventilation? (67362 D). J. J. Blackmore. 5500 w. A S H V E Jl—Jan., 1916. Study of factors.

The Ventilation of Living Quarters (67363 D). Ills. 3000 w. A S H V E Jl—Jan., 1916. Chicago commission on ventilation.

Warehouses
Operation of Warehouse Heating Plant of Merck & Co. Rahway, N. J. (67365 D). J. F. Cyphers. 2500 w. A S H V E Jl—Jan., 1916. Details of building, plant, and its operation.

Windows
Window Leakage (67360 D). Stephen F. Voorhees and Henry C. Meyer, Jr. Ills. 2000 w. A S H V E Jl—Jan., 1916. Tests on metal-frame types, and methods of reducing.

HYDRAULIC MACHINERY

Air Lift
Lifting Ground Water by Compressed Air (67475). W. L. Saunders. Read at second Pan-Am. Cong. Ills. 3500 w. C A M—Jan., 1916. Present condition of art; Pohle and Saunders system.

Pumps
Types of Pumps, Condensers and Cooling Systems (66926). Ills. 105 pp. P E, C—Jan. 1, 1916. Detailed descriptions and general information.

Screw Pumps
Huge New Orleans Screw Pump Shows 80% Efficiency (67264). W. H. P. Creighton and George G. Earl. Ills. 4200 w. E N—Jan. 13, 1916. Two articles on recent tests of drainage pumps of novel design.

Mammoth Screw Pumps of New Design Develop High Efficiencies for Low Lifts (67177). Ills. 2500 w. E R—Jan. 8, 1916.

Turbines
Bremsversuche an einer neuer schnellaufenden Wasserturbine von Escher Wyss & Cie (67010 B). F. Prasil. Ills. 2200 w. S B—Dec. 18, 1915. Serial, 1st part. Results of brake test on Escher Wyss high-speed water turbine.

Water Power
Status of Water-Power Development (67306). Hydrographs. 3500 w. El W—Jan. 15, 1916. Economic advantages of utilizing maximum stream flow with auxiliary steam stations.

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Waterwheels
Results of Tests on High-Head Waterwheels (67148). Ills. 2000 w. El W—Jan. 8, 1916. Methods and results.

MACHINE ELEMENTS AND DESIGN

Cone Couplings
Beitrag zur Berechnung von Kegelreibkupplungen und über Reibung und Schmierung (67045 B). H. Bonte. Ills. 2500 w. Z V d I—Dec. 18, 1915. Principles, friction and lubrication of cone couplings.

Gages
Gage-Making (67087 A). A. G. Robson. Ills. 1200 w. Mch W—Jan. 14, 1916. Internal and external cylindrical gages, and plate gages.

Gears
Gear Teeth Without Interference or Undercutting (66890 A). John Edgar. Ills. 4000 w. Mch—Jan., 1916. Designing and generating flanks.

Machine Tools
Report on Past Experimental Work on Cutting Tools (67023 D). Dempster Smith. Ills. 111 pp. M A E—Mar., 1915. General review.

Shafts
The Determination of Shaft Diameters (67250 A). William E. Wright. 800 w. Mch W—Dec. 31, 1915. Supplementing carlier articles. Diagrams to save calculations.

Spanners
Spanners and Their Angles (67089 A). James Stormonth. Diagrams. 2000 w. Mch W—Jan. 14, 1916. Designs and operation.

Springs
Helical Springs Under Centrifugal Action (66892 A). John S. Myers. Ills. 2500 w. Mch—Jan., 1916. Speed limit device when weight of spring is important.

Sprockets
Design and Construction of Sprockets (66894 A). B. D. Pinkney. Ills. 1800 w. Mch—Jan. 1916. Improvement in efficiency from accurate determination of dimensions.

MACHINE WORKS AND FOUNDRIES

Billiard Balls
Turning Ivory Billiard Balls (66887 A). Edward K. Hammond. Ills. 1500 w. Mch—Jan., 1916. Accuracy and finish with simple tools.

Chain
Making Chain Under Steam Hammers (67120 B). F. G. Coburn. Ills. 2500 w. I T R—Jan. 6, 1916. Methods at Boston Navy yard.

Die-Casting
The Production of Die-Pressed Castings (66885 A). Edward K. Hammond. Ills. 5000 w. Mch—Jan., 1916. Method and applications.

Drawing
Drawing Brass Shells and Other Press Work (67237 A). G. R. Smith. 1500 w. Mch W—Dec. 24, 1915. Working methods.

Flasks
Wooden Foundry Flasks (67358). Walter J. May. Ills. 500 w. B W—Jan., 1916. Flasks of moderate size produced at low cost.

Foundations
Casings for Machinery-Foundation Anchor Bolts (66923). Bruce Page. Ills. 1500 w. Pwr—Jan. 4, 1916. Formation of casings, materials, methods.

Foundry Practice
A Few Problems Confronting British Foundrymen (66934). H. Sherburn. 2500 w. Fnd—Jan., 1916. Waste in production.

The Modern Foundry Advance (66936). Richard Moldenke. From paper read before Am. Found. Assn. 3000 w. Fnd—Jan., 1916. Development, with summary of modern advances.

Gear Machine
The Largest Herringbone Gear Hobbing Machine (66891 A). Ills. 1800 w. Mch—Jan., 1916. Special machine for generating Wuest type of herringbone gears.

Grinding
The Story of the Grinding Wheel (67419 A). C. W. Blakeslee. From a paper read at conference of salesmen of Abrasive Material Co. 3000 w. I A—Jan. 20, 1916. Development. Odd uses and abuse.

Heat Treatment
Causes Underlying Steel Hardening (67254). Albert Sauveur. Ills. 2500 w. I T R—Jan. 13, 1916. Read at Int. Engng. Cong. Explanations of results.

Holding Devices
Holding Devices for Tapered Work (66895 A). Albert A. Dowd. Ills. 4500 w. Mch—Jan., 1916. Methods for either rough or finished work.

Machine Tools
History of Machine Tools (66886 A). Joseph W. Roe. Ills. 5000 w. Mch—Jan., 1916. Early development in England and United States.

Molding
Die Anfertigung eines Lehmmodells zu einem Spiralturbinengehäuse und das formen desselben (67042 B). L. Emmet sen. Ills. 1800 w. G-Z—Dec. 15, 1915. Procedure of making a clay model and patterns for a spiral turbine-housing.

Molding the Packard "Twin-Six" Motor Castings (66933). Ills. 2500 w. Fnd—Jan., 1916. Intricate core work.

Cheap Coreboxes (67238 A). James Edgar. Ills. 800 w. Mch W—Dec. 24. 1915. Methods.

Molding Machines
Jolt-Ram Machines for Light Castings (67114 B). Ills. 1500 w. I A—Jan. 6, 1916. Thin castings made at King Works. Buffalo.

Jolt-Ram Moulding Machines (67535 A). Ills. 700 w. Enr—Jan. 7, 1916. New machines built at Manchester, Eng.

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Patterns

Pattern Plates for Reducing Operating Costs (66935). D. Dalrymple. Presidential address to British Found. Assn. Ills. 3500 w. Fnd—Jan., 1916. Used to advantage in mechanical molding.

Projectiles

Shell Machinery and the Adaptation of Existing Machine Tools for Shell Making (67088 A). W. J. Eves. From paper before the Belfast Assn. of Engrs. 2000 w. Mch W—Jan. 14, 1916. Serial, 1st part. Various operations required in producing shells.

High Explosive Shell Making in Australia (66967 N). Ills. 3000 w. Cw E—Dec., 1915. What Australian firms are doing.

Making the 6-In. British High-Explosive Shells (67112 B). Ills. 3000 w. I A—Jan. 6, 1916. Routine for making 100 shells per hour.

Making Cartridge Cases on Bulldozers and Planers (66889 A). Douglas T. Hamilton. Ills. 1800 w. Mch—Jan., 1916. Details of operations.

Screw Machines

Cams and Tools for the Brown and Sharpe Automatic Screw Machine (67408 A). W. Richards. Ills. 1000 w. Mch W—Jan. 7, 1916. Serial, 1st part. Methods in designing.

Shop Practice

Efficient Reclamation of Bolts and Nuts (67274). E. T. Spidy. Ills. 1000 w. R M E—Jan. 1916. Shop practice in handling.

Getting the Most Out of Tools (67275). B. W. Benedict. Abstract of paper presented to Am. Ry. Tool Foremen's Assn. 1500 w. R M E—Jan., 1916. Factors affecting efficiency.

Turret Lathe Practice (67409 A). Joseph Horner. Ills. 2000 w. Mch W—Jan. 7, 1916. Serial, 1st part. Details of accepted methods.

How Steel Pens Are Manufactured (67122 B). E. C. Kreutzberg. Ills. 3000 w. I T R—Jan. 6, 1916. Preparing steel and process of manufacture in American plant.

Shops

New Features in Forge Shop Design (67562 A). Ills. 1500 w. I A—Jan. 27, 1916. Plant recently built in Detroit.

Plant of Pioneer Drop Forging Works (67111 B). Ills. 2500 w. I A—Jan. 6, 1916. Arrangement and equipment of new shops at Hartford.

First Principles of Shop Planning (67452). F. M. Perkins. Ills. 3000 w. I T R—Jan. 20, 1916. Pattern shop and new general foundry of Puget Sound Navy Yard, Bremerton, Wash.

Huge Remington Small Arms Factory Represents Effective "Preparedness" (67580). Ills. 3000 w. I T R—Jan. 27, 1916. Plant at Bridgeport.

Welding

Oxy-acetylene Welding Practice (66893 A). S. W. Miller. 3300 w. Mch—Jan., 1916. Sheet metal and boiler welding.

Autogenous Welding of Steel Tubing (67255 A). Ills. 2000 w. I A—Jan. 13, 1916. New process using continuous oxy-acetylene machines.

MATERIALS OF CONSTRUCTION

Alloy Steels

Manufacture and Uses of Alloy Steels (67474 N). Henry D. Hibbard. 70 pp. U S B M—Bul. 100. Information on composition, characteristics and application.

Aluminum Dust

Aluminum Dust (67553). G. H. Clevenger. 700 w. M & S P—Jan. 22, 1916. Uses. Danger from explosions.

Bearing Metals

Bearing Metals (67396 N). George H. Tinker. 1200 w. A R E A Bul—Oct., 1915. Tests and specifications.

Brass

Recrystallization of Cold-Worked Alpha Brass on Annealing (67430 D). C. H. Mathewson, and Arthur Phillips. Ills. 13500 w. A I M E, Bul—Jan., 1916. Metallographic study at Yale.

Chrome Steel

The Corrosion of High Chromium Steels (67418 A). Abstract of paper by Sir Robert Hadfield, read before the Faraday Society of England. 1000 w. I A—Jan. 20, 1916. Characteristics of "stainless steel."

Lubricants

Viscosity and Its Relation to Lubricating Value (67214). Alan E. Flowers. 3500 w. Pwr—Jan. 11, 1916. Effect on "body" and lubricating value of an oil.

Metal Supplies

The Future of the World's Metal Supplies (67099 A). Donald M. Liddell. 4500 w. E M—Feb., 1916. Analyzes present situation and draws conclusions.

Rubber

The Rubber Industry (66942). Andrew H. King. Ills. 5000 w. M & C E—Jan. 1, 1916. Serial, 1st part. Varieties of crude rubber, treatment, properties, etc.

Tars

Die praktische Prüfung des Stahlwerksteers (67055 B). Jos. Wagner. Ills. 3500 w. St u E—Dec. 23, 1915. Tests on utilization of steel-work tars.

Vanadium

Vanadium—Its Discovery and Qualities; Most Powerful Metal for Alloying Steel (66985 A). Ills. 800 w. R & L E—Jan., 1916.

MEASUREMENT

Anemometer

The Linear Hot-Wire Anemometer and Its Applications in Technical Physics (67446 B). Louis Vessot King. Ills. 6000 w. F I Jl—Jan., 1916. Experimental investigations, theory, description of instrument and applications.

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Conveyor Belts
Nomographic Charts for Conveyor Belt Calculations (66939). Robert E. Haylett. 500 w. M & C E—Jan. 1, 1916. Chart and use.

Hydraulics
Application of Newton's Second Law of Motion to Certain Hydraulic Problems (67479 A). Ford Kurtz. 1800 w. C C E Jan., 1916. Discusses two phases of the application. Mathematical.

Oil Flow
See same heading under CIVIL ENGINEERING *Measurement.*

Scales
Weighing-Scales (66888 A). F. J. Schlink. Ills. 4000 w. Mch—Jan., 1916. Principles of operation and methods of inspecting and testing.

Steam Piping
Vereinfachtes zeichnerisches oder rechnerisches Verfahren zur Bestimmung der Durchmesser von Dampfleitungen (67043 B). Brabbée and Wierz. 1400 w. G-I—Dec. 18, 1915. Simplified graphic and mathematical methods for calculating the size of steam pipes.

Synthesizer
A 32-Element Harmonic Synthesizer (67448 B). Dayton C. Miller. Ills. 4500 w. F I Jl—Jan., 1916. Methods of harmonic synthesis, description of apparatus, applications.

Turbine Efficiency
Calculation of Turbine Efficiency by Use of Mollier Diagrams (67151). H. A. Cozzens, Jr. 1000 w. El W—Jan. 8, 1916. Diagram and use.

POWER AND TRANSMISSION

Cement Plant
Power Plant of the Edmonton Portland Cement Co. (67536). A. G. Christie. Ills. 2000 w. Pwr—Jan. 25, 1916. Compact design; piping connections made as short as possible.

Factory Plants
Modernization of Power Plant in Factories (67251 A). W. A. Tookey. Read before Jun. Inst. of Engrs. 4000 w. Mch W—Dec. 31, 1915. Serial, 1st part. Details and difficulties.

Modernization of Power Plants in Factories (67086 A). W. A. Tookey. Read before the Jan. Inst. of Engrs. 5500 w. Mch E—Jan. 14, 1916. Serial, 1st part. Details to be considered in equipment to meet expected competition.

Electric Drive at Massillon Mill (67126 B). G. E. Stoltz. Ills. 1500 w. I T R—Jan. 6, 1916. Data of performance.

Motive Power
The World's Supplies of Fuel and Motive Power (67236 A). Thomas Hawksley lecture before Inst. of Mech. Engrs. Dugald Clerk. 3000 w. Mch E—Dec. 24, 1915. Serial, 1st part. Industrial power and its sources. Future prospects.

Signaling
Power Plant Signaling Systems (66930). Norman G. Meade. Ills. 2500 w. N E—Jan., 1916. Alarms, telephone systems, etc.

STEAM ENGINEERING

Boiler Code
Work of the Boiler Code Committee (67253 A). Ills. 4000 w. A S M E Jl—Jan., 1916. Gives 46 inquiries and replies.

Boiler Corrosion
Boiler Corrosion (66928). John B. C. Kershaw. 3500 w. N E—Jan., 1916. Effects of salts in water.

Boiler Design
Design of a Watertube Boiler (67276). C. W. R. Edichhoff. Ills. 1500 w. B M—Jan., 1916. Calculations.

Boiler Economy
See Boilers under MARINE AND NAVAL ENGINEERING.

Boiler Operation
Behavior of Boilers in Service (67538). J. C. McCabe. From paper before Detroit Engng. Soc. Ills. 5000 w. Pwr—Jan. 25, 1916. Causes and conditions which make trouble.

Condensing
See Pumps under *Hydraulic Machinery.*

Economizers
"Economizer Equation" (67511 A). Albert W. Smith. Diagrams. 1500 w. S Jl E—Jan., 1916. Derives equation and puts solution of problems into diagrams.

Engine Efficiency
Steam Engine Efficiency (66931). Charles L. Hubbard. 2500 w. N E—Jan., 1916. Serial, 1st part. Thermal and mechanical efficiencies; how affected by conditions.

Feed-Water Heaters
Economic Limit of Feed-Water Heating Surface (67537). F. H. Rosencrants. 1200 w. Pwr—Jan. 25, 1916. Furnishing plant with nearest correct amount for conditions of excess and insufficient exhaust steam.

Flue Gases
Sampling and Analyzing Flue Gases (67372 N). Henry Kreisinger and F. K. Ovitz. Ills. 60 pp. U S B M—Bul. 97. Information on methods and on utilization of analyses.

Fuels
Selecting and Buying Fuel (67465 N). W. H. Grady. 3000 w. A W P A—Jan., 1916. Methods for determining most economical fuel.

Power Plants
Construction and Operation of a Small Steam Plant (67072). Glenville A. Collins. Ills. 1800 w. El W—Jan. 29, 1916. Plant on Vashon Island furnishing energy to small communities and to about 25 industrial plants.

Smoke Abatement
See Furnace under *Heating and Cooling.*

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Turbines

Les progrès récents dans les moteurs a vapeur (67035 B). A. Foillard. Ills. 2600 w. G C—Jan. 1, 1916. Review of progress in steam-prime-mover design, especially turbines with double rotation.

Valves

Nonreturn Stop Valves (67321). Ills. 3500 w. Pwr—Jan. 18, 1916. Serial, 1st part. Various types to prevent dangerous escape of steam.

TRANSPORTING AND CONVEYING

Cableways

Seilbahnlaufwerk mit Kupplung durch Eigen und Schlaggewicht (67047 B). G. W. Heinold. Ills. 2600 w. Z V d I—Dec. 25, 1915. New carriage for wire ropeway having grip actuated both by its own weight and by impact.

Aerial Cableway at Niagara Falls, Ont. (67490). Ills. 3500 w. Cn E—Jan. 20, 1916. Torres system for taking tourists over the whirlpool.

Cranes

20-Ton Metre-Gauge Railway Breakdown Crane (67336 A). Ills. 600 w. Eng—Dec. 31, 1915. Detailed description.

Derricks

See same heading under CIVIL ENGINEERING, *Construction.*

Electric Lifts

Control Gear for Electric Lifts (67324 A). Arthur L. Hawes. 2000 w. El R—Dec. 31, 1915. Modern types and methods of control.

Elevators

Semi-Automatic Lifts on the "Underground" (67327 A). Ills. 800 w. Eln—Dec. 31, 1915. Stations in London.

Hoists

Die Hebezeuge an der Schweizerischen Landesausstellung in Bern, 1914 (67034 B). Hans Krapf. Ills. 1600 w. S B—Jan. 1, 1916. Serial, 1st part. Review of lifting apparatus exhibited at Berne Exposition.

Material Handling

Handling Materials in Manufacturing Plants (67093 A). Ills. 7000 w. E M—Feb., 1916. Fourth article of a series. Operation and efficiencies of various types of hoists.

Pneumatic Transportation

Le transport pneumatique des matières en grains et principalement des blés (67049 B). Ch. Dantin. Ills. 2400 w. G C—Jan. 8, 1916. Pneumatic elevators in English granaries.

MISCELLANY

Cotton-Opening Machinery

Cotton-Opening Machinery (67239 A). Ills. 1200 w. Eng—Dec. 24, 1915. Machines used.

Magnetic Hand

Die magnetische Hand (67046 B). G. Klingenberg. Ills. 1000 w. Z V d I—Dec. 18, 1915. Magnetic hand for use of cripples.

Review of 1915

The Year's Review (66925). 3800 w. Pwr—Jan. 4, 1916. Progress and notable features of year.

Science

Science in Its Relation to Engineering (67252 A). Dr. John A. Brashear. Presidential address. 5000 w. A S M E Jl—Jan., 1910. Value of scientific research. No sharp line between pure and applied science.

MINING AND METALLURGY

BASE METALLURGY

Consolidated Arizona

Reverberatory Smelting at Consolidated Arizona Smelting Company, Humboldt, Arizona (66944). 1200 w. M & C E—Jan. 1, 1916. Plant, equipment, and methods.

Copper Metallurgy

Recent Progress in the Metallurgy of Copper (67449 B). Heinrich O. Hofman. 5000 w. F I Jl—Jan., 1916. Covering last ten years.

Metallurgy of Copper in 1915 (67160). Lawrence Addicks. 2200 w. E & M J—Jan. 8, 1916. Progress in leaching, roasting, melting, fume condensation, and refining.

Copper Refining

The Development of Electrolytic Copper Refining (67132). Lawrence Addicks. Read at Int. Engng. Cong. 2500 w. C M Jl—Jan. 1, 1916. Processes used.

Hydrometallurgy

Hydrometallurgy of Zinc and Lead in 1915 (66943). D. A. Lyon, O. C. Ralston, and J. F. Cullen. 3000 w. M & C E—Jan. 1, 1916. Plants and processes and advances during year.

Leaching

See Flotation under *Ore Dressing.*

Lead Metallurgy

Metallurgy of Lead in 1915 (67159). H. O. Hofman. 2000 w. E & M J—Jan. 8, 1916. Handling, smelting, desilverization methods, etc.

Review of 1915

Metallurgy in 1915 (66938). 3000 w. M & C E—Jan. 1, 1916. Review of the year's progress in the metallurgy of the precious metals, copper and zinc.

Zinc Metallurgy

Metallurgy of Zinc in 1915 (67161). W. R. Ingalls. 2500 w. E & M J—Jan. 8, 1916. Smelting, refining, electrolytic production.

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Zinc Works

The American Steel & Wire Company's Zinc Works (67115 B). Ills. 2000 w. I A—Jan. 6, 1916. Plant at Donora, Pa.

COAL AND COKE

Alberta

The Drumheller Coal Field, Alberta (67334 A). D. A. Macaulay. Ills. 1800 w. C G—Dec. 31, 1915. Mines in operation.

Byproduct Coke

Byproduct Coking Installation in Great Britain (67606). Frederick C. Coleman. Ills. 1200 w. Cl A—Jan. 29, 1916. Kopper's oven plant in north of England. Byproducts consist of gas, tar, sulphate of ammonia, and benzol.

Byproducts

Coal-Tar and Its Products (66910). 1200 w. E & M J—Jan. 1, 1916. Diagram.

Benzol (67244 A). George Taylor. Abstract of paper read before Coke Oven Mgrs. Assn. 1500 w. I & C T R—Dec. 24, 1915. Details of plant, distillation and purification.

Thermal Reactions in the Vapor Phase of Various Coal Tar Oils and Distillates (66940). Walter F. Rittman and Gustav Egloff. 2500 w. M & C E—Jan. 1, 1916. Experiments in low-grade coal-tar oils for production of valuable hydrocarbons.

The Comparative Value of Domestic Ammonium Sulphates and Imported Nitrates (67578). David T. Day. 900 w. M Rd—Jan. 27, 1915. Uses as fertilizers and as powerful explosives.

Coal Cutters

The "Hardiax" Coal Cutter (67246 A). Ills. 1500 w. I & T R—Dec. 24, 1915.

Coal Oil

The Production of Oil from Coal (67243 A). Ills. 1200 w. Enr—Dec. 24, 1915. Details of experimental plant at Chiswick.

Coke

The Effect of Aeration and "Watering Out" on the Sulphur Content of Coke (67438 D). J. R. Campbell. 1200 w. A I M E, Bul—Jan., 1916. Sulphur as pyrite and other forms.

Efficiency

Economies in a Small Coal Mine (67437 D). Herbert A. Everest. 700 w. A I M E, Bul—Jan., 1916. Value of mechanical devices, concentration, and supervision.

Explosions

The Limits of Inflammability of Mixtures of Methane and Air (67373 N). G. A. Burrell and G. G. Oberfell. Ills. 25 pp. U S B M—Tech. paper 119. Study of causes; experiments on self-propagation of flame.

Firedamp Detector

A New Firedamp Detector (67498). George A. Burrell. Ills. 1500 w. Cl A—Jan. 22, 1916. Apparatus to supplement electric lamp.

Mining Methods

Mining by Concentration Method (67284). Ills. 2500 w. Cl A—Jan. 15, 1916. Method employed successfully in the Pittsburgh district.

Montana

Geology and Coal Resources of Northern Teton County, Montana (67379 N). Eugene Stebinger. Maps. 140 pp. U S G S, Bul 621-K—Jan. 5, 1916. Value and quantity.

Nova Scotia

The Coal Trade of Nova Scotia in 1915 (67130). F. W. Gray. 2200 w. C M Jl—Jan. 1, 1916. Production.

Pulverized Coal

Pulverized Coal—Its Preparation and Use in Industrial Furnaces (67097 A). S. H. Harrison. Ills. 5000 w. E M—Feb., 1916. Highly economical results in applications other than power.

Reviews of 1915

Business Aspects of the Coal Industry in 1915 (67180). A. T. Shurick. 4000 w. Cl A—Jan. 8, 1916. Review; depression followed by expansion.

The Coal Trade of 1915 (67522 A). 33500 w. C G—Jan. 7, 1916. Review by districts, with editorial.

Reviews of Coal Mining in 1915 (67179). 2800 w. Cl A—Jan. 8, 1916. Reports from state mine inspectors.

The Coal and Coke Trades of the United Kingdom in 1915 (67342 A). 22000 w. I & C T R—Dec. 31, 1915. General and district reviews, with editorial.

Roof Support

Controlling Roof Weights (67344 A). W. Dakin. Read before the Nat. Assn. of Col. Mgrs. Ills. 7000 w. I & C T R—Dec. 31, 1915. Methods in coal mines. Also discussion.

Storage-Battery Locomotives

The Goodman Storage Battery Locomotives—Particularly the Articulated Type (67609). E. C. De Wolf. Ills. 1500 w. M & E W—Jan. 29, 1916. Details of new design.

Tipples

Simplicity in Tipple Design (67605). R. G. Miller. Ills. 1500 w. Cl A—Jan. 29, 1916. Details of steel structure in Pomeroy, Ohio.

GEOLOGY

Igneous Rocks

The Later Stages of the Evolution of the Igneous Rocks (67392 N). N. L. Bowen. 90 pp. Jl G—Nov.-Dec., 1915. (Sup.) New conception of origin.

Iron Ranges

A Revision of the Sequence and Structure of the Pre-Keweenawan Formations of the Eastern Gogebic Iron Range of Michigan (67391 N). R. C. Allen and S. P. Barrett. Also discussion of correlation. C. K. Leith and R. C. Allen. Map. 40 pp. Jl G—Nov-.Dec., 1915. Results of recent studies.

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Ore Persistence
Theoretical Considerations Governing the Persistence of Ore (67413). T. A. Rickard. Ills. 4000 w. From a paper presented to the Inst. M. & M., London, with additions. Chief arguments against such persistence.

Queensland
Copper Deposits of the Wide Bay and Burnett Districts (67445 N). Lionel C. Ball. 2500 w. Q G M Jl—Dec. 15, 1916. Describes the different localties.

IRON AND STEEL

Blast Furnace Practice
The Mechanical Principles of the Blast Furnace (66946). J. E. Johnson, Jr. Ills. 6500 w. M & C E—Jan. 1, 1916. Effects of blast pressure.

Blast Furnaces
Completes First of New Furnaces (67127 B). Samuel Higginson. Ills. 2000 w. I T R—Jan. 6, 1916. At Steelton works.

Canada
Canadian Supplies of Iron and Steel in Relation to Munitions of War (67426). Thomas Cantley. 3000 w. C M Jl—Jan. 15, 1916. Present conditions of industry, and development.

Electrometallurgy
The Electric Steel Industry's Present Status (67116 B). 2500 w. I A—Jan. 6, 1916. Review of progress since 1910.

Ueber Entschwefelung bei der Roheisendarstellung (67054 B). Ludvig M. Lindeman. Ills. 4000 w. St u E—Dec. 16, 1915. Experiments on desulphurization of pig iron conducted in the electric furnace.

Ferro-Manganese
Development of Ferro Manufacture (67118 B). C. J. Stark. Charts. 2000 w. I T R—Jan. 6, 1916. History in United States.

Gas Washing
Washing Blast Furnace Gas at South Chicago (67110 B). Ills. 2500 w. I A—Jan. 6, 1916. Method for total yield.

Menominee
Iron Mining on the Menominee (67451). H. Cole Estep. Ills. 4000 w. I T R—Jan. 20, 1916. Story of development of Porter lands.

Open Hearths
Improved Open-Hearth Checker Construction (67416 A). Ills. 1200 w. I A—Jan. 20, 1916. Improvement in output of ingots due to Danforth design.

Philippines
Primitive Iron Smelting in the Philippine Islands (67124 B). J. F. Springer. Ills. 2000 w. I T R—Jan. 6, 1916. Descriptive.

Pittsburgh
Pittsburgh Makes Its Greatest Record (67119 B). C. F. Williams. 5000 w. I T R—Jan. 6, 1916. Production during 1915.

Prices
Iron and Steel Prices for Eighteen Years (67107 B). Sup. 9 pp. I A—Jan. 6, 1916. Monthly averages covering period 1898-1915.

Review of 1915
Engineering Industries in 1915 (67526 A). 6500 w. Enr—Jan. 7, 1916. Review of iron and steel industries.

The Iron and Steel Trade in 1915 (67343 A). 18600 w. I & C T R—Dec. 31, 1915. District reviews, with editorial.

Iron and Steel (67158). Frederick Hobart. 4000 w. E & M J—Jan. 8, 1916. Review of year. Also Pittsburgh markets, by B. E. V. Luty.

Iron and Steel Works Problems in 1915 (67108 B). J. E. Johnson, Jr. 4500 w. I A—Jan. 6, 1916. Serial, 1st part. Chiefly commercial.

Iron Range Developments in 1915 (67125 B). H. Cole Estep. Ills. 6500 w. I T R—Jan. 6, 1916. Important developments.

Rolling
Beitrage zur Berechnung des Walzdruckes und der Walzarbeit (67060 B). Karl Lang. Ills. 4000 w. St u E—Jan. 6, 1916. Mathematical consideration of points in rolling practice.

Rolling Mills
Newest Type of Merchant Bar Mill (67123 B). Ills. 1000 w. I T R—Jan. 6, 1916. New Duquesne mill.

Steel Works
New Iron and Steel Works Construction (67117 B). 10800 w. I A—Jan. 6, 1916. Report of new works completed and in progress.

Youngstown Street and Tube Co. Completes Important Improvements (67128 B). Ills. 1200 w. I T R—Jan. 6, 1916. General description.

L'usine métallurgique allemande Adolf Emil, à Eschsur-Alzette (Luzembourg) (67002 B). A. Pawlowski. Ills. 5500 w. G C—Dec. 18, 1915. General description of the Emil steel works situated in Luxembourg.

Tin-Plate Plants
Largest Tin Plate Plant in World (67121 B). C. F. Williams. Ills. 2500 w. I T R—Jan. 6, 1916. Details of plant at McKeesport, Pa.

MINE OPERATION

Change Houses
Modern Wash House for Miners (67280). John A. Garcia. Ills. 1800 w. Cl A—Jan. 15, 1916. House meeting requirements.

Electrical Troubles
Some Electrical Troubles and their Remedies (67248 A). Thomas Anderson. Read before the Assn. of Min. Elec. Engrs. Also discussion. 4500 w. I & C T R—Dec. 24, 1915. Cases of electrical faults commonly occurring, and their remedies.

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Gasoline Locomotives

Gasoline Mine Locomotives in Relation to Safety and Health (67594 D). O. P. Hood and R. H. Kudlich. With a Chapter on Methods of Analyzing Exhaust Gases, by George A. Burrell. Ills. 74 pp. U S B M—Bul. 74. Investigation described.

Hydraulic Stripping

Stripping the Hillcrest Iron Mine with a Sand Pump (67074). Ills. 3500 w. E & M J—Jan. 29, 1916. Hydraulic giant used for stripping capping from ore body and handled by sand pumps.

Law

Relation of Governments to Mining (67131). Horace V. Winchell. Read at Int. Engng. Cong. 2000 w. C M Jl—Jan. 1, 1916. Serial, 1st part. Broad discussion.

Chinese Mining Legislation (67592 N). William F. Collins. 10500 w. I M M—Jan. 13, 1916. Recent developments affecting mining in China, with constructive criticism of regulations proposed.

Pumping

Pumping Installations in the Leadville District (67517). Albert E. Guy. Ills. 1200 w. M & E W—Jan. 22, 1916. Recent installations.

Rock Drilling

Drilling in Narrow Stopes (66970). P. B. McDonald. Ills. 2500 w. M & S. P—Jan. 1, 1916. Methods, and care of drills.

Sampling

Taylor's Pulp Sampler (67593 N). W. H. Trewartha-James. Ills. 1800 w. I M M—Jan. 13, 1916. Details of new machine.

Stoping

Broken Hill Underground Mining Methods (67432 D). E. J. Horwood. Ills. 6000 w. A I M E, Bul—Jan., 1916. Methods varied in accordance with character of ore.

Underground Mining Methods of Utah Copper Co. (67431 D). Thomas S. Carnahan. Ills. 2500 w. A I M E, Bul—Jan., 1916. Shrinkage stoping as auxiliary and preliminary to steam-shovel operations.

Ventilation

Effect of Barometric Pressure to Derange or Stop Ventilation (67499). F. C. Cornet. 1800 w. Cl A—Jan. 22, 1916. Fall causes outflow of gas.

Important Features in Mine-Ventilating Fans (67283). H. H. Valiquet. 1800 w. Cl A—Jan. 15, 1916. Advises fans best suited to lending themselves to changing requirements.

Mine Ventilation Stoppings, with Especial Reference to Coal Mines in Illinois (67540 N). R. Y. Williams. Ills. 20 pp. U S B S—Bul. 99. First cost of several types, and expense of maintaining.

Warehouses

Mine Warehouse System (67281). E. I. Roberts. Plan. 2500 w. Cl A—Jan. 15, 1916. Serial, 1st part. Suggestions for the handling of supplies.

MINES AND DISTRICTS

Alaska

Mining in Alaska in 1915 (67212). Alfred H. Brooks. Maps. 4500 w. M & S P—Jan. 8, 1916. Advance statement of U. S. Geol. Survey.

Australasia

Mining in Australasia in 1915 (67170). W. P. Geary. 2000 w. E & M J—Jan. 8, 1916. Production of gold, silver, lead, zinc, and tin.

Austria-Hungary

Die Metallversorgung der österreichisch-ungarischen Monarchie (67001 B). L. St. Ranier. 4800 w. M R—Dec. 1, 1915. Position of Austria-Hungary in production, use and supplies of the metals.

Bolivia

Bolivian Mining in 1915 (67506). P. F. Bliek and M. G. F. Sohnlein. Map. 3000 w. E & M J—Jan. 22, 1916. Tin, copper, and other ores.

Central America

Central America in 1915 (67166). 600 w. E & M J—Jan. 8, 1916. Review of operations.

Colorado

Mining in Colorado in 1915 (67508). 2000 w. E & M J—Jan. 22, 1916. Summary.

Idaho

Mining in Idaho (67507). Robert N. Bell. 3500 w. E & M J—Jan. 22, 1916. Exploration and increased production.

Japan

Mining in Japan in 1915 (67288). H. W. Paul. 1500 w. E & M J—Jan. 15, 1916. Production of coal, copper, gold and silver and other minerals.

Oatman

Oatman, Arizona—A Prohibition Camp (66971). Frank H. Probert. Ills. 3000 w. M & S P—Jan. 1, 1916. General and geological.

The Tom Reed-Gold Road Mining District, Arizona (66909). J. D. Sperr. Ills. 2000 w. E & M J—Jan. 1, 1916. Location, early history, present activity.

Ontario

Mining Districts of Northern Ontario (67414). Robert Livermore. Ills. 3000 w. M & S P—Jan. 15, 1916. Mining and geological features of region.

Mining in Ontario in 1915 (67167). Thomas W. Gibson. 1200 w. E & M J—Jan. 8, 1916. Gold, nickel, copper, and iron production.

Russia

Mining in the Russian Empire, 1915 (67169). John Power Hutchins. 2500 w. E & M J—Jan. 8, 1916. Effects of war: production, development, methods, etc.

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South America
South America in 1915 (67165). 2500 w. E & M J—Jan. 8, 1916. Review by countries.

Transvaal
Transvaal Mining in 1915 (67168). H. F. Marriott. 2000 w. E & M J—Jan. 8, 1916. Production, improvements, etc.

United States
A Preliminary Review of U. S. Mining in 1915 (67178). 17000 w. M & E W—Jan. 8, 1916. Preliminary review issued by the U. S. Geological Survey.

Utah
Mining in Utah in 1915 (67289). Edward R. Zalinski. 2500 w. E & M J—Jan. 15, 1916. Production of copper, gold, silver, lead and zinc ores.

MINOR MINERALS

Antimony
Antimony (67210). 1200 w. M & S P—Jan. 8, 1916. Review of sources. Outline of metallurgy.

The Behavior of Stibnite in an Oxidizing Roast (67433 D). H. O. Hofman and John Blatchford. 1200 w. A I M E, Bul— Jan., 1916. Investigations and conclusions.

The Determination of Antimony in the Products Obtained by Roasting Stibnite (67434 D). William T. Hall and John Blatchford. 600 w. A I M E, Bul—Jan., 1916. Chemical work; analyses.

Nouveaux moyens de production de l'antimoine en France (67036 B). M. Biver. Ills. 2500 w. G C—Jan. 1, 1916. New antimony smeltery in France.

Barium
The Barium Industry in the United States Since the European War (66947). Maximilian Toch. Ills. 2200 w. M & C E—Jan. 1, 1916. Explains economic conditions.

Fertilizers
The Fertilizer Situation in the United States (67129). D. F. Houston. 3000 w. M Rd—Jan. 6, 1916. Supply of potash, phosphate and nitrogen.

Phosphate
Discovery of Phosphate Rock in the Rocky Mountains (67031 N). Frank D. Adams and W. J. Dick. Ills. 36 pp. Comm of Conserv, Can., 1915. Successful scientific prospecting.

Platinum Substitutes
A Development of Practical Substitutes for Platinum and Its Alloys, with Special Reference to Alloys of Tungsten and Molybdenum (67435 D). Frank Alfred Fahrenwald. Ills. 45 pp. A I M E, Bul—Jan., 1916. Metallurgical research work and results; especially for dental work.

Potash
Evaporation of Potash Brines (67383 N). W. B. Hicks. 3000 w. U S G S, Prof. paper 95-E—Oct. 25, 1915. Experiments and results.

Salt
The Salt Industry of Central Kansas (67543). Charles I. Corp. Ills. 3000 w. W E—Jan., 1916. Methods and processes.

Stone
The Stone Industry in 1914 (67377 N). G. F. Loughlin. 70 pp. U S G S, II: 33—Dec. 31, 1915. Statistical data, and historical review since 1880.

Tin
Tin Industry in 1915 (67157). 1800 w. E & M J—Jan. 8, 1916. Review; smelting in the United States; tin in Bolivia.

Cassiterite in San Diego County, California (67473 N). Waldemar T. Schaller. Map. 1200 w. U S G S, Bul 620-P—Jan. 15, 1916. Describes deposit.

Tungsten
Scheelite Mining and Grading (67211). P. B. McDonald. Ills. 1000 w. M & S P—Jan. 8, 1916. Occurrence in gold-quartz ore; graded by eye.

Wolframite Mining in the Tavoy District, Lower Burma (67591 N). 4500 w. I M M—Jan. 13, 1916. Discussion of E. Maxwell-Lefroy's paper.

See also same heading under ELECTRICAL ENGINEERING, *Illumination*.

Vanadium
See Ore Dressing.

OIL AND GAS

Canada
Petroleum and Natural Gas Resources of Canada. Vol. II. (67011 N). Frederick G. Clapp and others. Ills. 404 pp. C D M—No. 291. Occurrences.

Gasoline
The Future of the Country's Gasoline Output (67563 A). Alexander E. Outerbridge, Jr. 1500 w. I A—Jan. 27, 1916. Demand exceeds supply. Rittman and Hall processes.

Gasoline from "Synthetic" Crude Oil (67440 D). 1200 w. A I M E, Bul—Jan., 1916. Discussion of paper of Walter O. Snelling.

Oil Flow
See same heading under CIVIL ENGINEERING, *Measurement*.

Oklahoma
Amazing Conditions of Activity in Oil Fields of Oklahoma (67257). C. M. Sarchett. 1800 w. M Rd—Jan. 13, 1916. Gasoline demand increases business.

Petroleum Production
Petroleum Production Large (67512 A). 2500 w. S Jl E—Jan., 1916. Output for 1915 estimated at over 290,000,000 bbls.

Petroleum in 1914 (67472 N). John D. Northrop. 200 pp. U S G S, II: 34—Jan. 12, 1916. Review of developments in industry.

Refining
Equilibrium Relations Among Aromatic Hydrocarbons Produced by Cracking Petroleum (67024 N). W. F. Rittman and T. J. Twomey. Ills. 3000 w. Jl I E C—Jan., 1916. Conclusions from experiments.

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Shale Oil

The Oil-Shale Industry (67444 N). Lionel C. Ball. 12500 w. Q G M Jl—Dec. 15, 1916. Introduction to report; nature, distribution and treatment.

Tennessee

Oil and Gas Conditions in the Central Basin of Tennessee (67029 N). A. H. Purdue. Ills. 15 pp. R T—Jan., 1916. Topography, geology, details of operations.

Oil and Gas Conditions in the Reelfoot Lake District of Tennessee (67030 N). A. H. Purdue. Ills. 20 pp. R T—Jan., 1916. Topography, geology, probabilities.

Texas

Natural Gas Resources of Parts of North Texas (67382 N). Articles by Eugene Wesley Shaw, George Charlton Watson, and Carroll H. Wegemann. Maps. 120 pp. U S G S—Bul. 629. Reports of investigations.

Wells

The Control of Petroleum and Natural Gas Wells (67436 D). Alfred G. Heggem. Ills. 3000 w. A I M E, Bul—Jan., 1916. Methods recently introduced to safeguard lives and property.

Wyoming

Oil and Gas Near Basin, Big Horn County, Wyoming (67539 N). Charles T. Lupton. Maps. 34 pp. U S G S, Bul 621-L—Jan. 21, 1916. Data and information.

ORE DRESSING

Flotation

Progress of Flotation in 1915 (67163). Herbert A. Megraw. Map.. 2500 w. E & M J—Jan. 8, 1916. Important facts, applications of process, theory.

Flotations in 1915 (66937). 1500 w. M & C E—Jan. 1, 1916. Editorial review.

New Ideas About Flotation (66913). Ills. 600 w. E & M J—Jan. 1, 1916. New machines.

Carrie Jane Billings Everson (67287). Ills. 4500 w. E & M J—Jan. 15, 1916. Information concerning discovery of process.

Pine Oil for Flotation (66912). C. F. Sherwood. 500 w. E & M J—Jan. 1, 1916. Report of test, showing its influence.

Testing Ores for the Flotation Process (66969). O. C. Ralston and Glenn L. Allen. Ills. 3500 w. M & S P—Jan. 1, 1916. Serial, 1st part. Machines and processes in use.

The Electrical Theory of Flotation (67412). David Cole. 2000 w. M & S P—Jan. 15, 1916. Letter referring to Badins' article.

Why Is Flotation? (66968). George Huston. 1500 w. M & S P—Jan. 1, 1916. Discussion of theory.

Flotation at Broken Hill, N. S. W. (67076). 1200 w. E & M J—Jan. 29, 1916. System at Central mine.

Flotation in Cuba (67555). Ills. 600 w. M & S P—Jan. 22, 1916. Methods and results at Cobre mine near Santiago.

Flotation Replaces Cyanide (67290). R. W. Smith. Ills. 2500 w. E & M J—Jan. 15, 1916. Details of installation at Freeland, near Idaho Springs, Colo.

Oil Flotation and Copper Leaching at the Washoe Smeltery (67544). Freeman D. Lohr. 2000 w. W E—Jan., 1916. New equipment recently installed, with theoretical explanations of flotation.

See also Philip Argall under *Miscellany.*

Grinding

Chilean Mills Versus Stamps (66911). Alexander McClaren. 2000 w. E & M J—Jan. 1, 1916. Stamps used with high-speed and with slow-speed chilean mills.

North Star

The Central Mill of the North Star Mines Co. (66945). Leroy A. Palmer. Ills. 3000 w. M & C E—Jan. 1, 1916. Using amalgamation, concentration, and cyanidation.

San Juan

Recent Milling Practice in San Juan County, Colorado (67300). Etienne A. Ritter. Ills. 4000 w. M & E W—Jan. 15, 1916. Operations are either concentration and flotation, or concentration and magnetic separation of zinc and copper.

Vanadium

Experiments on the Separation of Vanadium from Crude Sodium Uranate (66941). Howard H. Barker and Herman Schlundt. 5500 w. M & C E—Jan. 1, 1916. Experiments and results.

PLACER MINING

Dredging

Gold Dredging in 1915 (67164). Robert E. Cranston. 2500 w. E & M J—Jan. 8, 1916. Review of work and conditions.

A California Dredge with Two Tailings Stackers (67505). Lewis H. Eddy. Ills. 2500 w. E & M J—Jan. 22, 1916. A dredge equipped with means for resoiling the area it dredges.

Jigs on a California Dredge (67073). Lewis H. Eddy. Ills. 1000 w. E & M J—Jan. 29, 1916. Grinding mill and jig system installed on a dredge and successfully used.

PRECIOUS METALLURGY

Cobalt

The Metallurgy of Canadian Cobalt Ores (67425). Ralph W. Bridges. 3000 w. C M Jl—Jan. 15, 1916. Serial, 1st part. Tables and notes.

Cyaniding

Influence of Heat in Cyaniding Gold Ores (67590 N). 3500 w. I M M—Jan. 13, 1916. Discussion of E. A. Wraight's paper.

Metallurgical Practice in the Witwatersrand District, South Africa (67439 D). 1500 w. A I M E, Bul—Jan., 1916. Discussion of paper of F. L. Bosqui.

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Blast Furnace Smelting of Cyanide Precipitate (67318). Regis Chauvenet. 4000 w. M & C E—Jan. 15, 1916. Early method and new departure.

Review of 1915

Metallurgy of Gold and Silver (67162). Herbert A. Megraw. 2500 w. E & M J—Jan. 8, 1916. Progress during 1915.

MISCELLANY

Copper

Economics of the World's Supply of Copper (67415). Thomas T. Read. 1000 w. M & S P—Jan. 15, 1916. Abstract of paper before Int. Engng. Cong. Ore reserves; copper trade.

Legislation

Uniform Mine Legislation (67282). 2500 w. Cl A—Jan. 15, 1916. Serial, 1st part. Points brought out by members of Mine Inspectors' Inst., U. S. A.

Mineral Resources

The Public Interest in Mineral Resources (67345 N). George Otis Smith. 5000 w. U S G S—I: A, Dec. 31, 1915. Part I of review of mineral resources of United States.

Philip Argall

Philip Argall and Metallurgical Progress (67554). T. A. Rickard. Ills. 9000 w. M & S P—Jan. 22, 1916. An interview. Review of experience and progress.

Production

Gold and Silver in 1914 (67541 N). H. D. McCaskey. 40 pp. U S G S, I: 23—Jan. 20, 1916. General report.

Lead in 1914 (67380 N). C. E. Siebenthal. 27 pp. U S G S, I: 22—Jan. 14, 1916. General report.

Reviews of 1915

Copper Industry in 1915 (67154). Map. 7000 w. E & M J—Jan. 8, 1916. General review; statistics of production; districts; smelting, etc.

Gold and Silver (67152). Frederick Hobart. 2200 w. E & M J—Jan. 8, 1916. Production and commercial movement.

Production of Lead in 1915 (67155). Map. 4500 w. E & M J—Jan. 8, 1916. General review; production; districts, etc.

Chart of Metal Prices in 1914 and 1915. Also Course of Metal Prices since 1879 (67153). E & M J—Jan. 8, 1916. Charts plotted from monthly and annual averages.

Zinc Industry in 1915 (67156). 3500 w. E & M J—Jan. 8, 1916. General review; production; districts; smelting, etc.

Silver

Silver Market Conditions in China (67441). G. G. S. Lindsey. 1200 w. C M I—Jan., 1916. Tables of export and import of silver, with explanation of financial conditions.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION

Accidents

The Jarrow Disaster (67339 A). 2000 w. Enr—Dec. 31. 1915. Board of Trade inquiry.

A Disastrous Collision with an Unusual Cause (67495). Ills. 2000 w. R A G—Jan. 21, 1916. Butting collision on the Nashville, Chattanooga & St. Louis.

Signaling

The Economics of Railway Signaling (67186). A. G. Shaver. 2500 w. R R—Jan. 8, 1916. Importance of interlocking and block signaling for economical and efficient operation.

Review of the Past Year in Signaling (67189). 5000 w. R S E—Jan., 1916.

Power Equipment for Alternating Current Signalling at Interlocking Plants (66977 A). Harry M. Jacobs. Ills. 2200 w. G E R—Jan., 1916. Classifies requirements; equipment necessary.

Remedies for Track Circuit Ailments (67190). James Anderson. Ills. 5000 w. R S E—Jan., 1916. Locating and treating signal failures.

A. C. Signaling for Chicago Terminals (67191). Map. 2000 w. R S E—Jan., 1916. From Committee report of Chicago Assn. of Commerce. Cost of changing systems.

New Alternating Current Signal Installation on the Grand Trunk (67141). Ills. 1500 w. R A G—Jan. 7, 1916. Unusual track circuit conditions.

New Automatic Signals on Grand Trunk (67188). B. Wheelwright. Ills. 3500 w. R S E—Jan., 1916. Adoption of A. C. system on 19-mile section.

Snow

Railway Engineering in the Northwest—Rotary Snow Plows and Snow Sheds Ready for Winter (66979 A). Ills. 2000 w. R & L E—Jan., 1916. Problems and methods of solving.

Keeping a Railroad Line Open During Snow Storms (67496). Two articles by Coleman King and by W. G. Dungan. 3000 w. R A G—Jan. 21, 1916. Methods under different conditions.

Train Rules

The Lately Revised Standard Code (67271). Harry W. Forman. 2500 w. R A G—Jan. 14, 1916. Serial, 1st part. Considers train rules and examiners.

Train Shocks

The Cause of Shocks in Long Freight Trains (67273 A). H. C. Priebe. From paper before the Car Foremen's Assn. of Chicago. 1000 w. R M E—Jan., 1916. Road conditions, slack in trains, suggestions.

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MOTIVE POWER AND EQUIPMENT

Air Brakes

Charging Trains with E. T. Equipment (66984 A). 2500 w. R & L E—Jan., 1916. Suggestions for handling modern L. N., P. C., and U. C. brake equipments.

Anti-Collision Coach

Anti-Collision Railway Carriages (67026 A). Ills. 600 w. R E—Jan., 1916. Recent patented armored and reinforced construction.

Bath Train

Der Vereins-Badezug Rotes Kreuz Cöln (Stiftung L. Hagen). (67058 B). D. Rudolph and Meyer. Ills. 1200 w. G A G B—Dec. 15, 1915. Red Cross bathing train, general description of equipment and operation.

Boiler Cleaning

The Cleaning of Locomotive Boilers (67519 A). E. J. H. South. Read before the Inst. of Loc. Engrs. Ills. 3500 w. R G—Jan. 7, 1916. Serial, 1st part. Reviews methods employed.

Boiler Inspection

Annual Report of the Chief Inspector of Locomotive Boilers (67143). 1600 w. R A G—Jan. 7, 1916. Extracts from report of Frank McManamy.

Box Cars

Atchison, Topeka & Santa Fe Steel End Box Cars (67268). Ills. 700 w. R A G—Jan. 14, 1916. Details of cars of 40 tons capacity.

Car Inspection

Denver Joint Car Interchange and Inspection Bureau (67194 A). William Hansen. 1000 w. R M M—Jan., 1916. Inspection facilities and their effect on reducing cost.

Car Maintenance

The Upkeep of Railway Wagons (67340 A). 2000 w. Enr—Dec. 31, 1915. Review of cost.

Dining Cars

New Dining Cars on the Canadian Northern Railway (67195 A). Ills. 2000 w. R M M—Jan., 1916. Novel features of construction.

Dynamometer Cars

Southern Railway High Capacity Dynamometer Cars (67491). Ills. 1500 w. R A G—Jan. 21, 1916. Detailed description.

Electrification

The Electrification of Transportation Lines (67311). Norman Wilson Storer. 6500 w. El T—Jan., 1916. Read before Pan-Am. Sci. Cong. Reasons for electrification, results accomplished, the problems, etc.

Possibilities of Steam Railroad Electrification (67493). William Arthur. Abstract of lecture at N. Y. University. 3500 w. R A G—Jan. 21, 1916. Reasons why electricity is gradually replacing steam.

Tentative Designs for Terminal Facilities in the Electrification of Chicago Railways (67297). Map and Ills. 2500 w. R R—Jan. 15, 1916. Changes necessary; extracted from committee's report of Chicago Assn. of Commerce.

Electric Traction on the Giovi Line (67325 A). Ills. 2400 w. Eln—Dec. 31, 1915. Serial, 1st part. Information from foreign sources concerning results.

Locomotive Equipment

A Pair of British Old-Timers (66982 A). Ills. 500 w. R & L E—Jan., 1916. Particulars of engines built in 1853-54.

Pacific Type of Locomotive for the Delaware, Lackawanna & Western Railroad (66983 A). Ills. 1500 w. R & L E—Jan., 1916. Dimensions and description.

Powerful Mikado Type of Locomotive for the Missouri, Oklahoma and Gulf Railway (66981 A). Ills. 800 w. R & L E—Jan., 1916. Detailed description.

Two Powerful 4-6-2 Locomotives (67272 A). Ills. 1500 w. R M E—Jan., 1916. One burns anthracite, the other bituminous. Data and dimensions.

Locomotives

The Future of the Steam Locomotive (67185). John E. Muhlfeld. 3000 w. R R—Jan. 8, 1916. Conclusion that it will remain standard unit of motive power.

Locomotive Tests

Tests of a Mountain Type Locomotive (67233 A). W. J. Tollerton. Ills. 1200 w. R G—Dec. 24, 1915. Chicago, Rock Island & Pacific tests.

Reversing Gears

Locomotive Reversing Gears (67411 A). From *The Locomotive*. Ills. 1500 w. Mch W—Jan. 7, 1916. Designs and action.

Valve Gears

Simple Method of Adjusting the Walschaerts Valve Gear (66980 A). Clarence Bodemer. 700 w. R & L E—Jan., 1916. Details of method.

PERMANENT WAY AND BUILDINGS

Construction

Methods and Equipment Used in Railway Construction (67038). William C. Sloan. 2200 w. Cnr—Jan. 15, 1916. Part of paper before Inter. Engr. Cong.

Suction Dredges in Railroad Construction (67545). E. R. Stivers. Ills. 900 w. W E—Jan., 1916. Details of work on the C. B. & Q. railroad.

Drainage

Formation and Prevention of Pockets and Soft Places (67218 A). C. A. Davis. 2500 w. R E & M W—Jan., 1916. Importance in construction and maintenance.

Efficiency

Efficiency in the Railway Bridge and Building Department (67223). George W. Rear. Read before Am. Ry. Bridge & Bldg. Assn. 3500 w. E & C—Jan. 12, 1916. Suggestions.

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Grade Separation

Methods and Value of Grade Separation at Crossings (67220 A). Ills. 1500 w. R E & M W—Jan., 1916. Cost of elimination and of protection.

Reinforced Concrete

Unit System of Reinforced Concrete for Railway Structures (67204). Shirley Houghton. Ills. 1500 w. W E—Jan., 1916. Serial, 1st part. Erection of precast units.

Standardization

A System for Standardizing Maintenance of Way Work (67394 N). Earl Stimson. 5000 w. A R E A Bul—Oct., 1915. Benefits to be derived. System of B. & O. Railroad.

Stations

"Gilded Stairs and Marble Halls" (67094 A). Reginald Gordon. Ills. 4500 w. E M—Feb., 1916. Plea for more practical construction in railroad stations.

Ties

Durability Records of Cross Ties (67471 N). C. P. Winslow and C. H. Teesdale. 2500 w. A W P A—Jan., 1916. Tabulated data, with introductory notes.

Report of Committee on Service Tests of Cross Ties (67470 N). Ills. 2500 w. A W P A—Jan., 1916.

Woods Suitable for Cross Ties (67469 N). R. Van Metre. 1000 w. A W P A—Jan., 1916. Requirements, mechanical and other.

Track Accessories

Manganese Steel Crossings (67007 C). C. Haines. Ills. 7 pp. P-W I Jl—Dec., 1915. Use by Metropolitan Railway. Results.

Test of Track Bolts and Wrenches (67395 N). Earl Stimson. Ills. 2000 w. A R E A Bul—Oct., 1915. Relation between loads on the bolts when drawn up tight with various length wrenches and elastic limit of bolts. Advantages of standardization.

Track Maintenance

Proper Organization of Section Forces and Methods for Maintaining and Policing Track (67009 N). 54 pp. Main Way Bul—Nov. 10, 1915. Three reports of sub-committees covering heavy and light track and terminals, with extensive discussion.

The Permanent Track Organization on the Long Island (67497). G. P. Williams. 1700 w. R A G—Jan. 21, 1916. Efficiency greatly increased.

The Duties of a Platelayer (67008 C). G. Hughes. 22 pp. P-W I Jl—Dec., 1915. Practical hints in track repair.

Train Sheds

Reinforced Concrete Train Shed of Unit Construction (67068). Ills. 3000 w. R A G—Jan. 28, 1916. Construction details at Los Angeles, Calif.

ROADS AND PROJECTS

Asia Minor

La situation des chemins de fer en Asie Mineure et les projets germano-turcs (67003 B). V. Roux. Ills. 1500 w. G C—Dec. 18, 1915. Asia Minor's railroads and projects.

Baltimore & Ohio

The Magnolia Cut-Off on the Baltimore & Ohio Railroad (67217 A). Ills. 2200 w. R E & M W—Jan., 1916. Lower grades and reduced mileage.

Canadian Pacific

The Canadian Pacific Railway System (67331 A). 1400 w. R G—Dec. 31, 1915. Review of expenses and revenue during the year ending June 30, 1915.

Chesapeake & Ohio

Building the Chesapeake & Ohio Northern Railway (66995). Ills. 3700 w. E N—Jan. 6, 1916. Heavy rockwork.

New Haven

Improvements at Pawtucket and Central Falls (67140). Ills. 2200 w. R A G—Jan. 7, 1916. New Haven completing four-track line and station and eliminating grade crossings.

N. Y. Connecting R. R.

First All-Rail Through Route Across New York City (67263). Ills. 2700 w. E N—Jan. 13, 1916. Also editorial. Description and perspective view.

Russia

Railway Construction to Russia's Northern Ports. 67641.) Map. 1500 w. R R—Jan. 29, 1916. New routes to relieve congestion at Archangel and give access to Kola.

TRAFFIC

Car Pooling

The Wagon Pooling Project (67245 A). B. P. Wilson. 3000 w. I & C T R—Dec. 24, 1915. Organized system as remedy for congestion.

Chicago

The Railway Traffic of the Chicago Terminal (67265). 2500 w. R A G—Jan. 14, 1916. Statistics on magnitude and growth of freight and passenger business.

France

French Railway Traffic and the War (67240 A). 2200 w. Eng—Dec. 24, 1915. Review of traffic receipts and expenditures.

Freight Handling

Starting Right in Handling L. C. L. Freight Traffic (67139). 6000 w. R A G—Jan. 7, 1916. Papers received in contest. Importance of properly preparing parcels for shipment.

Immigration Service

Federal Immigration Service and the Railroads (67145). W. L. Stoddard. 1000 w. R A G—Jan. 7, 1916. Comments on suggestions in report of Commissioner General A. Caminetti.

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MISCELLANY

Fuel Department

The Fuel Department—A Constructive Criticism (67299). L. G. Plant. Read before the New England R. R. Club. 3000 w. R R—Jan. 15, 1916. Urges an organization that may give a workable standard for American railways.

National Defense

Our Railroads and National Defense (67267). Charles O. Haines. From an article in Sept. *N. Am. Rev.* 1600 w. R A G—Jan. 14, 1916. Urging a Railroad Bureau of National Defense.

Railway Economics

The Influence of Modern Engineering on the Future of Railway Economics (67187). Onward Bates. 3000 w. R R—Jan. 8, 1916. Problems to be solved.

Railway Problems

Some Suggestions for the Improvement of the Railroad Situation (67492). W. J. Moroney. 3000 w. R A G—Jan. 21, 1916. States some of the problems and gives outline of general suggestions on direction of improvements.

Review of 1915

Railways (67532 A). 3000 w. Enr—Jan. 7, 1916. Reviews briefly events in the United Kingdom, India, Australia, Africa, South America, European continent, etc.

Statistics

Comparative Railway Statistics (67231 A). 2500 w. R G—Dec. 24, 1915. Serial, 1st part. Information from bulletin of Bureau of Railway Economics concerning the principal countries.

STREET AND ELECTRIC RAILWAYS

Accident Prevention

Safety First in Seattle (67181). George Carson. 3000 w. El R Jl—Jan. 8, 1916. Methods which have reduced accidents on street railways.

Carhouses

Carhouse Design and Construction (67611). C. F. Bedwell. Abstract of paper read before the Am. Elec. Ry. Assn. 1500 w. El R Jl—Jan. 29, 1916. Outlines considerations affecting location, architecture and equipment.

Bay State Carhouse at Lowell (67610). Ills. 1500 w. El R Jl—Jan. 29, 1916. Main features and detailed costs.

Car Operation

Fundamental Principles of Car Operation Efficiency (67315). C. C. Chappelle. Graphs and curves. 7000 w. El R Jl—Jan. 15, 1916. Study of principles involved in use of time-element factors.

Cars

New Car for Public Service Railway (67314). H. A. Benedict. Ills. 900 w. El R Jl—Jan. 15, 1916. Sample car undergoing service tests.

Competition

The Electric Railway and the Automobile (67182). Ernest Gonzenbach. 2000 w. El R Jl—Jan. 8, 1916. Competition serious; remedies.

Contact Systems

Notes on Overhead Construction in Oakland, Cal (67309). Ills. 2000 w. El T—Jan., 1916. Types employed.

Development

Electric Railways (67234 A). Henry Metcalf Hobart. 2500 w. Mch E—Dec. 24, 1915. Serial, 1st part. "Jame Forrest" lecture. Progress, merits, cost.

Load Dispatching

Load Dispatching at East St. Louis (67513). Harold W. Clapp. Ills. 2500 w. El R Jl—Jan. 22, 1916. Method of centralizing control of power distribution.

Los Angeles

Big Problems of Transportation (67310). Paul Shoup. 1800 w. El T—Jan., 1916. Electric and interurban railways in Los Angeles and vicinity.

Return Feeders

The Return Feeder System of the Interborough (67514). I. W. Gross. Ills. 1200 w. El R Jl—Jan. 22, 1916. Negative layout on subway lines; benefits from insulated feeder system.

Snow

Snow-Fighting Apparatus (67515). H. Bates. 2000 w. El R Jl—Jan. 22, 1916. Methods of disposing of snow.

Public Service Railway Company Snow Sweeper (67308). H. A. Benedict. Ills. 1200 w. El T—Jan., 1916. Details of design.

Steel Cars

Steel Cars for Cache Valley Route (67307). Ills. 1000 w. El T—Jan., 1916. Motor cars and trailers for high-speed interurban service.

Substations

Automatically Controlled Substations with Particular Reference to Their Application to Interurban Electric Railways. (67685 D.) 1500 w. A I E E, Pro—Feb., 1916. Discussion of paper of E. W. Allen and Edward Taylor at San Francisco, Cal., Sept. 16, 1915.

Tracks

Estimating Cost of Track Construction on a Unit-Time Basis (67183). Carl H. Fuller. 3300 w. El R Jl—Jan. 8, 1916. Method particularly for labor.

We supply copies of these articles. See page 979. Order by title and number

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EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cents. A, denotes a price of 40 cents; B, 60 cents; C, 80 cents; D, $1.00; E, $1.20; F, $1.60. The letter N indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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REFERENCE LIST OF PUBLICATIONS REGULARLY REVIEWED AND INDEXED

ARRANGED IN ORDER OF THEIR ABBREVIATIONS

A A	Aerial Age
A & B	Architecture & Building
A A P C M	Assn. Amer. Portland Cement Mfrs.
Acr	Autocar
A El S	American Electrochemical Society
A E R	American Economic Review
Aern	Aeronautics
A E S	Assn. Engineering Societies
A F A	Amer. Foundrymen's Assn.
A I & S I	Amer. Iron & Steel Institute
A I C E	Amer. Institute of Chemical Engineers
A I E E	Amer. Institute of Elec Engineers
A I M E	Amer. Institute of Mining Engineers
A I Mt	Amer. Institute of Metals
A J P H	Amer. Journal of Public Health
A J S	Amer. Journal of Science
A M S	Australian Mining Standard
A R	Architectural Record.
A R B A	Amer. Road Builders' Assn.
A R E A	Amer. Ry. Engineering Assn.
A S	Applied Science
A S C E	Amer. Soc. of Civil Engineers
A S H V E	Amer. Soc. of Heat. & Vent. Engineers
A S M D	Amer. Soc. of Marine Draftsmen
A S M E	Amer. Soc. of Mechanical Engineers
A S N E	Amer. Soc. of Naval Engineers
A R C A O	Assn. of Trans. & Car Acct. Officers
Au-R	Automobil-Rundschau
Aut	Automobile
A W A	Amer. Water Works Assn.
B C Bul	Barge Canal Bulletin
B E C	Brooklyn Engineers' Club
B F & S P	Blast Furnace & Steel Plant
Bkbld	Brickbuilder
B M	Boiler Maker
B S C E	Boston Soc. of Civil Engineers
B u E	Beton und Eisen
B W	Brass World & Platers' Guide
C A M	Compressed Air Magazine
C-C A	Concrete-Cement Age
C C E	Cornell Civil Engineer
C D M	Canada Department of Mines
C E S	Cleveland Engineering Soc.
C G	Colliery Guardian
C I A At	Atti, Colleg. Ingegneri ed Arch.
Cl A	Coal Age
C M I	Canadian Mining Institute
C M Jl	Canadian Mining Journal
C M M S S A	Chem., Met., & Min. Soc. of South Af.
C M W A	Chamber of Mines of West. Australia
Cn E	Canadian Engineer
Cnr	Contractor
C R C	Central Railway Club
C S C E	Canadian Soc. of Civil Engineers
C S M M	Colorado School of Mines Magazine
C U Q	Columbia University Quarterly
C V	Commercial Vehicle
Cw E	Commonwealth Engineer
D W P B	Dominion Water Pow. Branch, Dept. Int.
E & C	Engineering & Contracting
E & M J	Engineering & Mining Journal
E C	Engineering Contractor
E C D	Engineers' Club of Dayton
E C P	Engineers' Club of Philadelphia
E G	Economic Geology
E K u B	Elektrische Kraftbetriebe und Bahnen
El A	Electrical Age
El Jl	Electric Journal
Eln	Electrician
El R	Electrical Review
El R & W E	Electrical Review & West. Elec'n
El R Jl	Electric Railway Journal
El T	Electric Traction
El W	Electrical World
E M	The Engineering Magazine
E N	Engineering News
Eng	Engineering
Enr	Engineer
E R	Engineering Record
E Ru	Elektrotechnische Rundschau

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E S P	Engineers' Soc. of Pennsylvania
E S W P	Engineers' Soc., West. Pennsylvania
E u M	Elektrotechnik und Maschinenbau
E Z	Elektrochemische Zeitschrift
Feuer	Feuerungstechnik
F I	Franklin Institute
Fnd	Foundry
G A	Gas Age
G A G B	Glaser's Ann. für Gewerbe u Bauwesen
G E R	General Electric Review
G-I	Gesundheits-Ingenieur
Glk	Glückauf
Gn Cv	Génie Civil
G R	Good Roads
G W	Gas World
G-Z	Giesserei-Zeitung
H A	Horseless Age
H & V M	Heating & Ventilating Magazine
I A	Iron Age
I An	Anales de Ingenieria
I & C T R	Iron & Coal Trades Review
I & R	Ice & Refrigeration
I C E I	Inst'n, Civ. Engineers of Ireland
I C E	Institution of Civil Engineers
I E	Industrial Engineering
I E E	Institution of Electrical Engineers
I E S S	Instn, Engrs. & Shpbldrs of Scot.
I F	L'Ingegneria Ferroviaria
I I Bul	Bulletin of the Imperial Institute
I Mch E	Institution of Mechanical Engineers
I M E	Institution of Mining Engineers
I M M	Institution of Mining & Metallurgy
I Mr E	International Marine Engineering
Ind	L'Industria
Ing	Ingénieur
I S C A M A	Iowa State Col. of Agri. & Mech. Arts
I S E	Institute of Sanitary Engineers
I T R	Iron Trade Review
Jl Act	Journal of Accountancy
Jl G	Journal of Geology
K A E	Keighly Assn. of Engineers
La Nt	La Nature
L S M I	Lake Superior Mining Institute
M A E	Manchester Assn. of Engineers
M & C E	Metallurgical & Chemical Engineering
M & E R	Mining & Engineering Review
M & E W	Mining & Engineering World
M & S P	Mining & Scientific Press
M B M A	Master Boiler Makers' Assn.
Mch	Machinery
Mch E	Mechanical Engineer
Mch W	Mechanical World
M E & N A	Marine Engineer & Naval Architect
M I	Metal Industry
M Jl	Mining Journal
M Mg	Mining Magazine
M M S A	Mining & Metallurgical Soc. of Amer.
M R	Montanistische Rundschau
M Rd	Manufacturers' Record
M Rv	Marine Review
M T	Monitore Tecnico
Mun E	Municipal Engineering
Mun Jl	Municipal Journal
N E	National Engineer
N E C I E S	N-E Coast Instn., Engrs. & Shpbldrs.
N E W W A	New England Water Works Assn.
N F A Sf Bul	National Founders' Assn. Saf. Bulletin
N G M	National Geographic Magazine
N L M A	National Lime Manufacturers' Assn.
Nt	Nature
N Y R C	New York Railroad Club
O S M E S E	Ohio Soc., Mech., Elec. & Steam Engrs.
P B S	Philippine Bureau of Science
P C An	Annales des Ponts et Chaussées
P E, C	Practical Engineer, Chicago
P Jl S	Philippine Journal of Science
P R	Polytechnische Rundschau
P-W I	Permanent-Way Institution
Pwr	Power
Q G M Jl	Queensland Government Mining Journal
Qry	Quarry
R A G	Railway Age Gazette
R & L E	Railway & Locomotive Engineering
R C P	Railway Club of Pittsburgh
R E	Railway Engineer
R E & M W	Railway Engineering & Maint. of Way
R G	Railway Gazette
R G S	Revue générale des Sciences
R M	Rivista Marittima
R M E	Railway Mechanical Engineer
R Met	Revue de Métallurgie
R M M	Railway Master Mechanic
R R	Railway Review
R S A	Royal Society of Arts
R S E	Railway Signal Engineer
R T	Resources of Tennessee
R T C	Revue Trimestrielle Canadienne
R U S I	Royal United Service Institution
S A	Scientific American
S A E	Society of Automobile Engineers
S & I	Steel & Iron
S & S-W R C	Southern & Southwestern Ry. Club
S A S	Scientific American Supplement
S B	Schweizerische Bauzeitung
S C A An	Anales de la Soc. Cientif. Argentina
Sch	Schiffbau
S C I Rv	Revista, Soc. Cubana de Ingenieros
S E	Society of Engineers
S E I N	Société d'Encourag., Indus. Nation.
Sf E	Safety Engineering
S I	Stevens Indicator
S I A I An	Annali, Soc., Ingeg. e Archit. Ital.
S I C F	Société, Ingenieurs Civils de France
S I E	Société Internation. Électriciens
S Jl E	Sibley Journal of Engineering
S L R C	St. Louis Railway Club
S M	Scientific Monthly
S M C E	Surveyor & Municip. & County Engr.
S M Q	School of Mines Quarterly
S N A M E	Soc., Naval Arch. & Mar. Engineers
S P S M	Soc. to Promote Sci. of Management
S R & M E	Sanitary Rec. & Municip. Engineer
St u E	Stahl und Eisen
T & R W	Tramway & Railway World
T E	Telephone Engineer
T E A	Traveling Engineers' Assn.
Tly	Telephony
T S	Travelers Standard
T T	Teniente Topics
T u W	Technik und Wirtschaft
U E E S	Utah Engineering Experiment Station
U I	University of Illinois
U M	University of Minnesota
U M S M M	Univ. of Mo. School of Min. & Metall.
U N P	Universidad Nacional de la Plata
U S B M	U. S. Bureau of Mines
U S B S	U. S. Bureau of Standards
U S C & G S	U. S. Coast & Geodetic Survey
U S D A	U. S. Dept. of Agriculture
U S G S	U. S. Geological Survey
U S N I	U. S. Naval Institute
W E	Western Engineering
W G N H S	Wis. Geol. & Nat. Hist. Surv.
Wis E	Wisconsin Engineer
W P I Jl	Jour. Worcester Polytech. Institute
W R C	Western Railway Club
Wrk	Werkzeugmaschine
W S E	Western Soc. of Engineers
Z g T	Zeitschrift, gesamte Turbinenwesen
Z V d I	Zeitschrift, Ver. deutsch. Ingenieure

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IMPROVED MACHINERY

NEW METHODS NEW MATERIALS
NEW PROCESSES NEW APPLIANCES

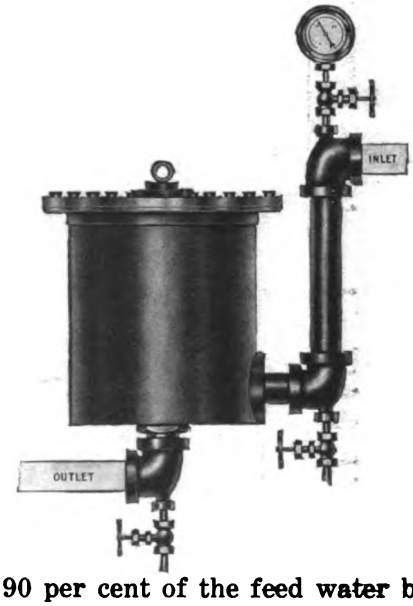
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

REMOVING OIL FROM FEED WATER

THE purpose of The Deoleizer is to take out oil. All previous devices have been some modified form of filter depending wholly upon mechanical interception. They have consisted of blankets, discs, baskets, trays, nettings, cartridges, etc., made of or filled with various kinds of filtration materials, such as hay, felt, excelsior, towelling, etc. The theory seemed to be that an ordinary sand or charcoal filter which would remove mud or visible impurities from water, would be altogether too coarse in its voids to intercept the minute suspended atoms of oil; hence it was thought that the substitution of some finer mesh like felt or towelling would form a more efficient strainer. It has been found, however, that straining will not remove all of the oil.

The Deoleizer abandons entirely the idea of mechanical filtration or straining. It depends for its effectiveness upon the affinity for oil of a newly discovered material; an affinity analogous to that of dry cement for water. It resembles granulated charcoal or old-fashioned gun powder. It is, however, quite different from these, being strictly mineral in its nature and is substantially indestructible.

The record of The Deoleizer by the ether test is the removal from an emulsion of 9,999,994 parts of oil in 10,000,000. The oil remaining is, therefore, equal to approximately one drop in one and a quarter barrels of water. It will be seen that the Deoleizer, therefore, permits all condensation to be returned to the boiler over and over again with absolute safety. The resultant saving



is 90 per cent of the feed water bill, a large saving in coal due to the complete elimination of scale, the cutting out of recurring bills for boiler compound, and an end to the expense and nuisance of cleaning boilers, as well as burned tubes and blistered plates.

The pamphlet issued by William Andrews, Inc., 120 Liberty Street, New York, describes this interesting discovery and is well worth sending for.

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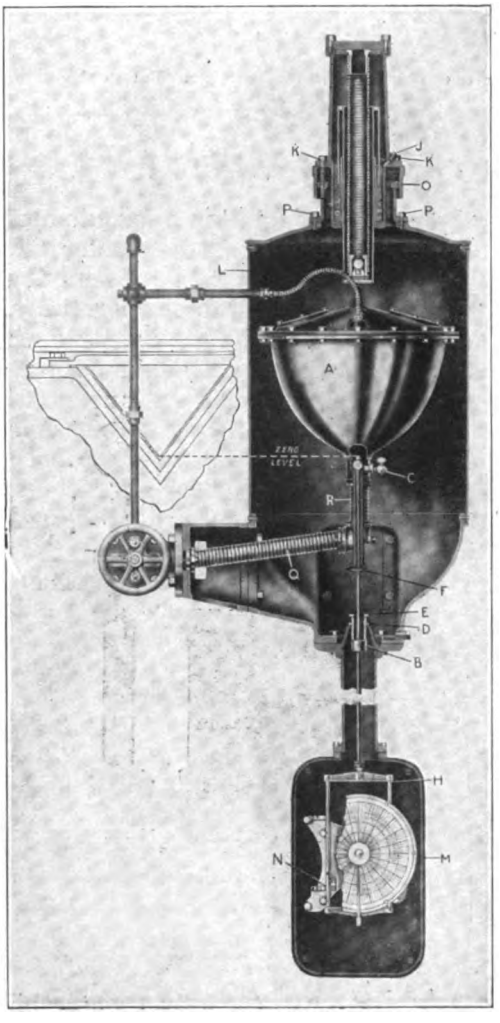
IMPROVEMENTS IN HOPPES V-NOTCH METER

SINCE the first Hoppes V-notch meters were put on the market by the Hoppes Manufacturing Co., some important changes have been made in details which allow more liberty in the location and permit easier adjustments as well as overcoming the effects of vibration of the meter support on the recorder.



This meter operates on the V-notch principle, the flow of the water over the weir being indicated and recorded on a revolving chart, the position of the pen being controlled by the head of water above the weir. This is accomplished by suspending a vessel of proper shape by a coil spring and providing a flexible water connection between the vessel and the water chamber back of the weir. An indicating rod attached to the vessel shows that the vessel lowers as the head above the weir rises; this deflection is in direct proportion to the flow of the water and is so recorded on the chart. The integrating wheel moves in unison with the recording pen and is kept in contact with the back of the revolving disc, thus its speed is proportional to the flow of the water over the weir.

One of the recent improvements was to make the guide on the recording head longer and heavier. This improvement has overcome the effect upon the pen record and integrator vibrations, which are considerable in many plants.

An improvement has been made in the recorder head which makes it possible to locate it either above or below the weighing cabinet. Where it is desired to place the tank on an elevation above the floor an inverted recorder head is supplied which brings the dial down to a convenient height, making it easy for the operator to read and change the charts. Fuller information will be furnished on request by the Hoppes Mfg. Co., Springfield, Ohio.

"NORMA" BALL BEARINGS NOW MADE IN AMERICA

AMONG the many preconceived notions which have been dispelled as a result of the European war, not the least well grounded was the belief that it was impossible for American shops and American workmen to produce antifriction bearings equal in quality, precision and uniformity to the imported bearings. It has been said

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that American mechanics were not temperamentally adapted to the quantity production of high-precision bearing parts over long periods.

However, the shutting-off of the supply of imported bearings created a situation in American industries which demanded relief. And American mechanical genius has proved equal to the emergency.

Among those bearing importers seriously affected by the outbreak of the war was The Norma Company of America, organized to handle in America the product of the Norma Campagnie of Cannstatt, Germany. The "Norma" line includes:—single and double annular ball bearings in all sizes from the smallest to the largest; roller bearings in all standard ball bearing sizes; single and double ball thrust bearings in all sizes and a variety of types; combined annular ball and ball thrust units; and combined roller and ball thrust bearings.

Very shortly after the introduction of the "Norma" ball bearing into this country, its recognized high speed qualities—the result of its extreme precision and silent-running character—led to its adoption practically as the standard bearing by makers of high-grade magnetos. And it was but a logical development of this magneto experience that "Norma" bearings soon came to hold, among makers of lighting generators and starting motors, the same position that had been accorded them by magneto manufacturers.

As early as 1912, the Norma Company of America had anticipated the necessity of making "Norma" bearings in America; and a small shop was established for preliminary and experimental work, with a view to determining whether American methods and materials could together produce bearings equal to the imported article.

The results were so gratifying, "the proof of American skill was so positive," that the shop activities of the company was gradually extended and the facilities enlarged, primarily with a view to meeting emergency demands where the imported bearings were not immediately available.

The outbreak of the war, and the subsequent inability to obtain German-made goods, for a time promised to affect seriously the business of the Norma Company. Fortunately, however, the Company was well stocked with bearing sizes having the largest demand, and had several large shipments in transit. These sufficed to tide over the situation, practically without any hardship to the trade, until the American factory could be enlarged sufficiently to meet the demand.

The Norma Company now has a most efficient, completely equipped and up-to-date ball bearing factory, turning out thousands of bearings daily in every way equal to the high-precision imported "Norma" bearings. And this factory is being steadily enlarged and increased in capacity, to keep pace with the growing demand for speed bearings of the "Norma" standard.

"Norma" bearings, however, are not limited in their use or application to automobile accessories. They have found increasing adoption in many other lines where service capacity combined with speed qualities, silent running and high precision, is fundamentally required. The successful outcome of the Norma Company's manufacturing enterprise is not only a triumph for American methods, materials, and mechanics, but is also an assurance that the dearth of high-grade imported bearings will not react disadvantageously on the quality of American machinery by forcing the use of inferior anti-friction bearings in the absence of foreign bearings.

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WELDED STEEL CASEMENTS

AFTER considerable experimenting a metal casement has been evolved which can be used in conjunction with wood frames.

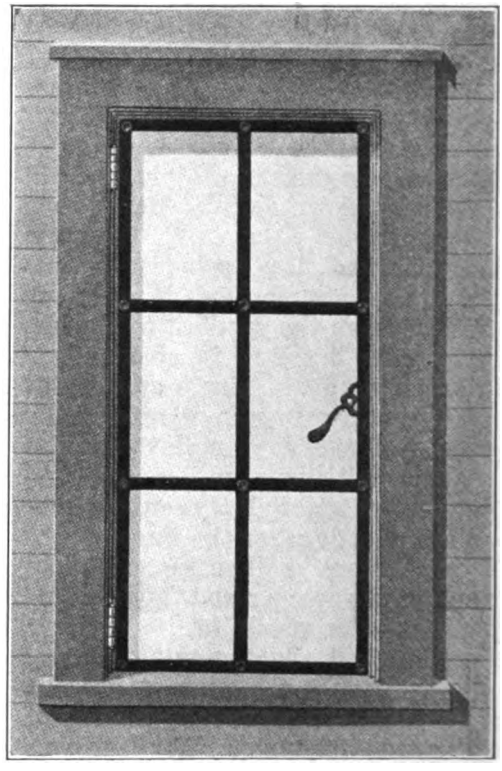
The combination of mechanical efficiency and improved appearance made possible will be a marked help to architects when designing medium or low priced houses. A natural development of the extensive use of the all metal casement and frame is residential construction where wide field is available for the use of this type of casement.

In an interview with E. J. Zahner, President of the Zahner Metal Sash & Door Company of Canton, Ohio, Mr. Zahner states that the insistent demand of the building trade for something of this sort prompted his company to take it up.

The principal points of the new casement are permanency, ease of operation, minimum obstruction to light and 100% ventilation. As in the older types of Zahner casements, the rigidity of construction prevents rattling and the warping, twisting and binding, common to wood casements.

During the prolonged and unprecedented rainy period which prevailed in the north central states during the past summer, when only the very best grades of wood casements and sash did not bind and stick, metal casements fully justified their use in all types of residences.

When the existence of this welcome addition to building materials



becomes generally known it is safe to assume that the majority of architects will be quick to realize its advantages.

Pratt & Cady Steam Specialties

The 1914 Catalogue of the Pratt & Cady Co. displays an unusually extensive line of valves, hydrants, steam traps, asbestos-packed cocks, etc., for all pressures. This line of goods is guaranteed by the manufacturer unconditionally to the extent of furnishing new material for any piece that may prove faulty in manufacture.

A new line of goods announced for January 1, 1916, is a Bronze Union-Bonnet Valve with renewable asbestos discs and renewable bronze seat rings. These valves embody the latest and best principles of Union-Bonnet constructions. The asbestos discs are both removable and replaceable in an instrument, while the valves remain in the pipe lines and the separate bronze seat rings screwed into the bodies may also be renewed without removing the valves from the lines. These valves are tested to 350 lbs.

The Pratt & Cady Co., Inc., Hartford, Conn., will be pleased to send a copy of this new catalogue on request.

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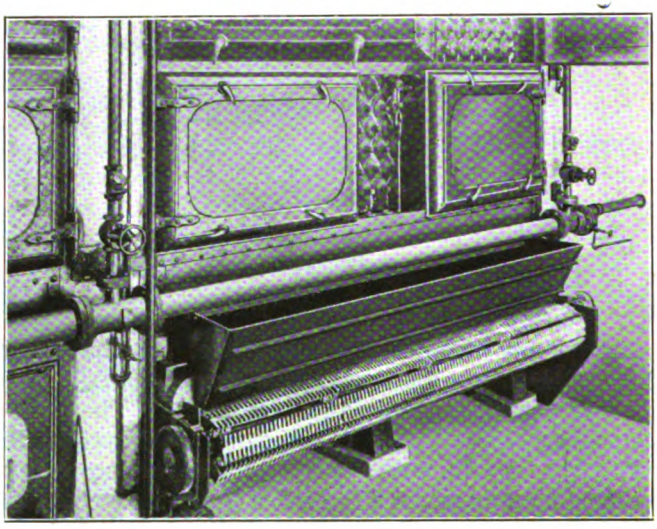
AUTOMATIC CHAIN GRATE STOKERS

THE accompanying photograph shows an installation under a 530 H.P. Babcock & Wilcox boiler of one of the Nosmoke Stoker Company's Automatic Chain Grate Stokers. The line cut shows a method of agitating the fuel bed and also a method of relieving the ash pit of its ashes.

It has been found advisable, by experience, to do away with cross walls or solid bridgings which depend upon the side walls for their support. This, of course, is because the expansion of such walls or bridgings is received by the side walls of the furnace, tending to crack them or at least disturb the mortar so that cooling air may enter the fire-box. The Stoker about to be explained was designed so that both it and the ignition arch are practically independent of the side walls for support.



The side frames of the Stoker are supported on wheels so that the Stoker may be withdrawn at any time. The entire run of grates is supported by the lower rollers so that the grate as a whole is flexible. For maintaining the proper distance between the upper and lower runs of grates, idlers are interposed between the upper and lower runs of chain and kept in lateral position by piping placed loosely in bearings on the side frames. Thus the upper run of grates bears on the idlers which in turn bear on the lower run which works over the lower rollers.

The driving mechanism is on the front shaft and consists of a double worm drive; that is, the worm shaft is itself driven by a worm, and this second worm is driven by a Reeves Variable Transmission which may be belted to a counter shaft or driven direct if direct drive is preferred.

Sprockets to receive the chains which carry the grates are keyed to the front shaft. The sprockets on the rear shaft are free to turn as is the rear shaft itself, thus overcoming any tendency for the upper or lower run of chain to bind due to inequalities of pitch in the chain. The chain is made up of clevis-like links which may be hooked together as a common hook and eye and which receive the grate bars. These latter are attached to the links by a heavy cotta pin. This pin passes through an elongated hole in the web of the grate bar in such a manner that the grate bar may have a free upward movement the distance necessary to properly agitate the fuel bed. This agitation simply requires that there be interposed at the proper intervals inclined obstructions in the course of the upper run of grate bars, and as may be seen, does not require any extra mechanism. The method of attaching the grate bars to the chain is so simple that they may be changed while the Stoker is in operation. The grate bars are of the best material for the purpose, and being used in multiple lengths of not

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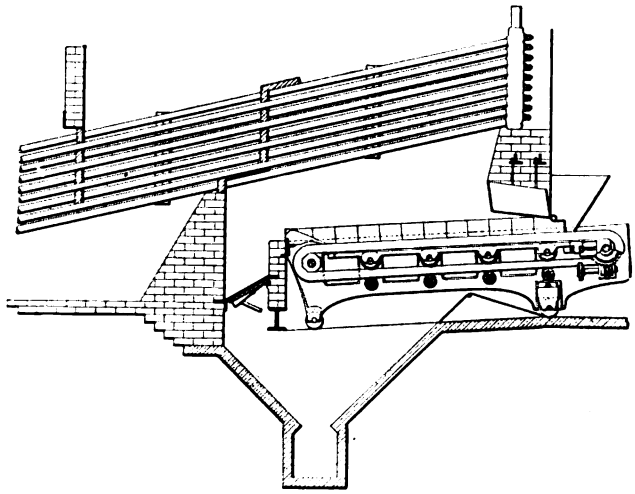
over three (3) feet, reduce the tendency to warp to a minimum and still have strength without the weight which a long grate bar would require. The grate bars intermesh leaving



openings for sufficient air passage, but not so large that coal can pass through, and automatically clean themselves.

In Stokers where the width of the fire-box exceeds seven (7) feet, a patented device is used to support the lower rollers, where the deflection, due to the weight of the grates, would be greatest. This adds only slightly to the cost and absolutely prevents any breaking down of the grate surface which is maintained in one plane.

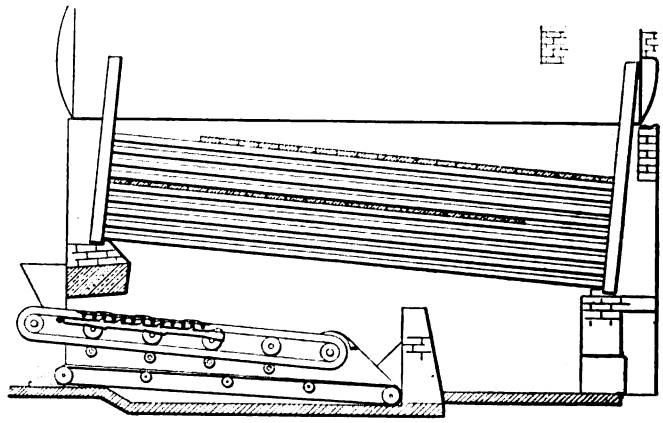
The ignition arch presents a flat under surface and is composed of multiple arches suspended from "T" beams supported by the side walls. These "T" beams are free to expand and contract without affecting their supports.

The retard plates which are air-cooled and situated at the rear of the Stoker, are so designed that the fuel bed at that part of the Stoker is backed up in order that the air will not pass any more freely through the ashes and partly consumed fuel, than it does through the burning fuel at the front where the fire is more intense.

The dumping arrangement at the rear of the Stoker is so designed that no air can pass through or around it to cool off the furnace gases, and is easily operated from the front by a lever. This, of course, may be designed to dump the ashes into the main ash pit where they may be removed by hand or conveyor or into an auxiliary ash pit and conveyor.

The grate is adjustable so that the depth of feed may be regulated.

The self-contained ash conveyor shown underneath the Stoker in the accompanying cut, is very simply operated as follows: The motion is actuated from the main drive and may be thrown on or off as desired.



Before dumping the ashes, the conveyor is put in operation and the fine coal which may have sifted through is first removed and shoveled back into the hopper, then the ashes are dumped and brought forward by the conveyor where they are handled as

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seen fit; that is, by a transverse conveyor, barrow or car. This Stoker may be operated by hand, should occasion arise, by simply removing the hopper and firing in the usual manner.

The arrangement of the arch in its relation to the grate is such that after the arch is heated by burning fuel on the grate, all the volatiles and unseen gases being released at the point of ignition are turned into heat units before escaping from the arch, thus adding to the efficiency of the fuel and consequently preventing the formation of smoke.

As there are different speeds in the travel of the grate, obtained by a Reeves Variable Transmission, it is possible, by a combination of grate travel and draught regulation, either natural, forced or induced, to obtain any required fire in the combustion chamber.

The fire is easily banked at night if required and quickly brought to its full efficiency in the morning.

Where the natural draught is affected by atmospheric conditions, a pipe filled with small holes is placed between the revolving grates immediately under the point of ignition and to which pipe is attached a blower. This is used when required to emphasize the ignition or to give the right mixture of oxygen.

It has been possible, due to the simplicity of the Stoker to eliminate a great deal of the machine work found on other machines, and makes it practically a foundry job, thus lowering the cost of production.

Owing to the simplicity and solidity of the construction of this Stoker, the maintenance of the Stoker is practically nil.

A very satisfactory test was made on this Stoker in August, 1913, by Prof. Frederick L. Bryor, of Stevens Institute of Technology, Hoboken, New Jersey. Results of this test may be seen at the office of the Nosmoke Stoker Company, 90 West Street, New York City, and any further information will be gladly furnished.

The Q & C Company Railroad Specialties

The new catalogue of the Q & C Co., 90 West Street, New York, contains much very interesting information for the railroad man. Illustrations are used profusely, in color, showing Bonzano Rail Joints of standard and special designs, Tie Plates, the Vaughan Rail Anchor (or Anti-Rail Creeper), Rail Braces, Car and Engine Replacers, Gilman-Brown Emergency Knuckles, Flangers, the Ross-Schofield System of Circulation of Water in Locomotive Boilers and Edman Refrigerator Car Doors.

The Q & C Co. will be glad to send this catalogue on application.

G. D. Bradshaw, Steam Engineer of the Cambria Steel Co., has tendered his resignation, and on Oct. 1st will enter business for himself at Pittsburg under the firm name of Andrews-Bradshaw Co. Mr. Bradshaw has been in the Steam Engineering Department of the Cambria Steel Co. for the past five years. Prior to that time, he was employed by the Indiana Steel Co. at Gary, for one year, and by the Illinois Steel Co. of Chicago, for five years. The Andrews-Bradshaw Co. will engage in the sale of equipment to steam power plants and will represent several well known manufacturers.

Mr. Bradshaw will have associated with him R. W. Andrews, who has had considerable experience in the sale of steam specialty equipment and who is well known throughout the Pittsburg district.

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NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors

INGERSOLL-RAND COMPANY, 11 Broadway, New York.—Bulletin No. 3035 just off the press describes, "Imperial" Type XPV Steam Driven Air Compressors. This new type, although differing in many respects from the machine which it supersedes, retains all the sound basic principles and the rugged simplicity upon which the previous type of "Imperial" Steam Driven Compressor was built.

Air Washers & Fans

BUFFALO FORGE COMPANY, Buffalo, N. Y.—Catalogue 13-21 fully describes the Carrier Air Washer and enters into the design and construction and the four essential features of an air washer which are the Eliminators, Spray Nozzles, Circulating Pump, and Scrubbing Surface.

Catalogue 201-21. This catalogue contains the capacity and horsepower tables of the Niagara Conoidal Fans. This fan is a multiblade fan which embodies the four basic requirements, High Efficiency, Noiseless Operation, Good Bearing, Rigid Construction. Both the Carrier Air Washer and Niagara Conoidal Fans are supplying cooled, purified air, free from dust and bacteria in many Schools, Offices, Factories and Public Buildings.

Babbitt Metals

LUMEN BEARING COMPANY, Buffalo N. Y.—Have recently issued a small booklet "Babbitt Metals." Their object in issuing this booklet is to acquaint you with their general line of babbitts, which are made under the supervision of their Laboratory, which directs the composition and controls the manufacture of all their alloys.

Ball and Roller Bearings

JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J.—"The Use and Abuse of Ball and Roller Bearings." This is the title of a new twenty page treatise by F. J. Jarosch, Chief Engineer of the Bearings Company of America. The text gives explanations and experiences which help in the selection, mounting and lubrication of ball and roller bearings in automobile gears and in all other rotating parts and is intended to help in detecting the real cause of trouble. Nineteen drawings are used to illustrate the text matter. A copy of this treatise may be obtained free upon request.

Boilers

A. D. GRANGER Co., 90 West Street, New York.—Bulletin pointing out some of the latest improved features now embodied in the "Oswego" Internally Fired Water Tube Boiler. Many illustrations showing various installations and Tables giving dimensions, rating and other data for both High and Low Pressure Boilers.

Boiler Valve

WM. POWELL Co., Cincinnati, Ohio.—Booklet illustrates a complete line of Boiler Valves manufactured by this company. These valves have been specially designed for the purpose indicated in the booklet.

Chain Drives

MORSE CHAIN COMPANY, Ithaca, N. Y. —Publication No. 13. Illustrating and describing the Morse Silent Chains and showing a few applications in Textile Mills. Contains also Data to be used in the design of Morse Chain Drives. The data is for use in the preliminary design.

Cork Insert Pulleys

THE CORK INSERT Co., 164 Federal Street, Boston, Mass.—Booklet gives tests and usage of Cork Insert Pulleys, Frictions, Clutches, Brakes, Tensions, Cones, etc., which are giving satisfaction where ordinary equipment has failed to meet the requirements.

Gas Engines

THE BRUCE-MACBETH ENGINE Co., 2103 Center St., N. W., Cleveland, have just issued a booklet "Bruce-Macbeth Gas Engines, and some Valuable Facts about Gas Power," which gives in concise form the principal advantages of gas power, together with some facts and figures regarding the results Bruce-Macbeth Gas Engines are giving in different kinds of service. It contains sections on Producer Gas Plants, Bruce-Macbeth Engineering Service, How to Obtain Maximum Efficiency from Gas Power Plants, The Meriam Steam Process for generating Steam as a by-product of Gas Engines; also a section of Gas Engine Data for the operators of gas engines.

Portable Tools

STOW MANUFACTURING Co., Binghamton, N. Y.—Booklet showing The Stow line of Portable Tools, Two Spindle Drill, Breast Drill, Tool Post Grinder, Bench Grinder, Buffer, Boring Machine, etc. They are furnished both belt and electric driven.

Slotting Machines

NEW MACHINE TOOL WORKS, INC., Philadelphia, Pa.—Catalogue 49 presents the complete line of their standard and special slotters. The smaller sizes are crank driven, while the larger sizes are driven by screw, or by rack and pinion. Illustrations also show machines driven by belt, pneumatic clutch and reversible motor. They also illustrate on the inserts a few of our many different designs of milling, boring, drilling and Cold Saw Cutting Off Machines.

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IMPROVED MACHINERY

NEW METHODS
NEW PROCESSES

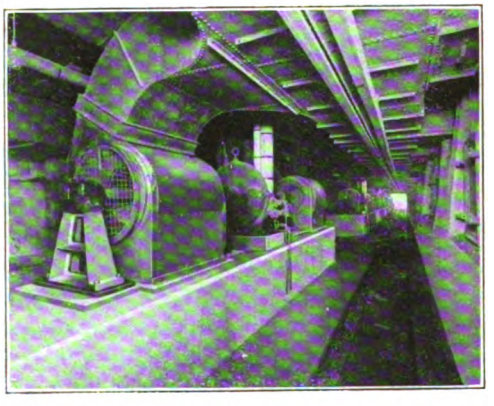
NEW MATERIALS
NEW APPLIANCES

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

LARGE UNDERFEED STOKER INSTALLATION

IN the Connellsville plant of the West Penn Traction Co. there is being made one of the largest recent installations of underfeed stokers. The portion of the plant now in service consists of 32 water tube boilers arranged in two batteries of 16 each. The boilers have a normal rating of 400 H. P., and are fitted with underfeed stokers, for which the air is supplied from 16 forced draft blowers in the basement. Eight fans supply air to each battery of boilers, the fans discharging into two main trunk lines, the arrangement and design of which may be seen in the cut. The fans are turbine driven and have angular up discharge, one fan of each pair delivering air into the main duct beneath one battery of boilers, and the other fan to the other battery, which makes it possible for any one of eight fans to supply air to any one of 16 boilers. The turbines are mounted between the two fans and drive from each end of the shaft. Steam pressure is 200 pounds, and the speed is throttle controlled. In order to insure each fan carrying its share of the load, all of the units are operated as nearly as possible at the same speeds, and dampers in the branch connections make it impossible for the air to blow back through the fans which are not running.

A feature which is of special interest is the design of the fans for a large air volume and at static pressures up to 6 inches at speeds suitable for direct connection to turbines. The maximum speed of these blowers is approximately 2,400 R. P. M., and this presents a problem for the fan designer, first to provide ample strength for continuous operation, and second to obtain good efficiency



at high speed. The first requisite is taken care of by details of construction not ordinarily seen in blower work. The bearings are mounted on heavy independent pedestals, are wedge adjusting for vertical alignment, and are of the ball and socket type with machined spherical surfaces. In addition they are fitted with special oil channels and with felt collars so as to prevent the high velocity of air passing over the bearings from drawing out the oil. Substantial thrust collars are enclosed within the bearing shell. The shafts are heavy steel forgings much larger

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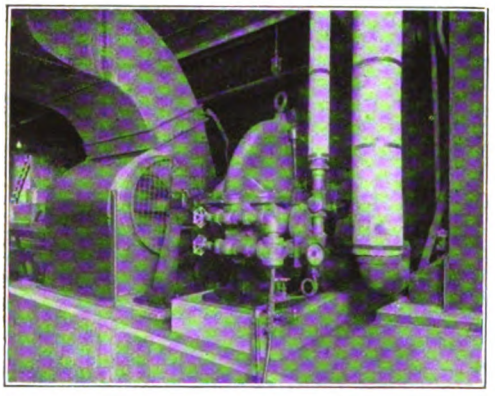
through the fan than in the bearings. The fan wheels, of which there are two in each housing, are of the type developed for this work and known



as "Turbo Conoidal." The blades are curved forward at the inlet edge to pick up the air without shock and at the outer edge are turned backward so as to permit high speed operation. To this double curvature is due a great part of the high economy. The shape of the Conoidal blade, which is approximately twice as great in radial depth at the back as at the inlet edge, also adds greatly to the strength; these blades are die formed and rivetted to a thick steel back plate, while the inlet flange is equally heavy and is braced by stay-rods from the hub casting. As the greatest strain on the wheel is due to rapid acceleration of speed and not to centrifugal action, the stay-rods are attached to the hub tangentially and carry the strains due to rapid increase and decrease of speed.

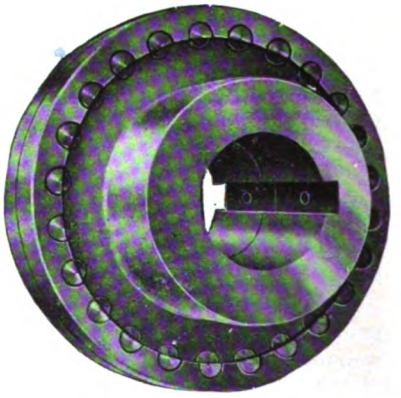
The forced draft blowers were furnished by the Buffalo Forge Company and are driven by Westinghouse turbines, while the stokers are Combustion Engineering Co.'s Type "E."

THE FRANCKE FLEXIBLE COUPLING

THE Francke Flexible Coupling reaches the maximum of simplicity, it being simply an ordinary flange coupling connected by *flexible* instead of rigid bolts. The flexible pins used are made of tempered steel leaves, held at each end by a keeper which prevents their getting loose or lost and makes of each pin a flexible bolt.

The keepers are slotted at each end to engage spring rings, which also fit in a groove in the coupling flanges. They hold the leaves in a radial position for driving, and also hold the keepers stationary in the coupling flanges.

All the leaves except two short ones at each end are slotted. The short ones are held stationary, making all movement come on the tempered steel leaves. The slotted leaves, —hundreds of them,—do the driving and distribute the work over a large area of hardened steel. The slots allow the coupling to adapt itself to any misalignment.



When shafts are out of line, the coupling wants to run open on one side and shut on the other. No other type of coupling will do this without excessive wear. A rigid coupling will burn out bearings or break shafts if forced to run out of line.

Address inquiries to Smith-Serrell Co., Inc., General Sales Agent, 138 Cedar Street, New York City.

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SPEED CONTROLLERS

FROM the customary interests of THE ENGINEERING MAGAZINE to a subject associated with the moving picture industry would seem to be a long pull, but warrantable we believe in this case in order to indicate to some degree the functions of a machine that is destined for numerous industrial applications.

The Speed Controller Company, Inc., of 257-259 William Street, New York City, is the manufacturer of an accurate controller, or governor, that is capable of controlling within very narrow limits the speed or distance, or direction of motion of various electrical and mechanical apparatus.

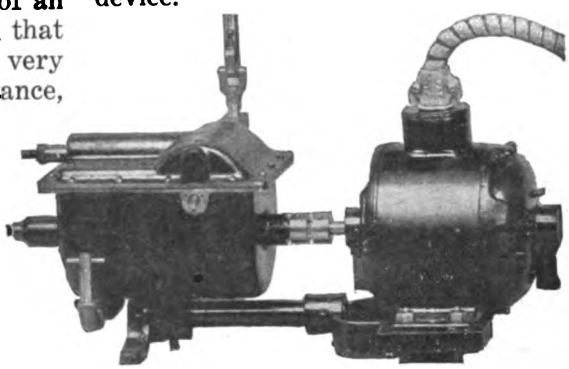
The initial commercial application of their product has been to the control of the feeding motion of the carbons of electric projection arcs, principally for moving picture purposes, in which field it has been notably successful and is responsible for the flickerless illumination of the pictures displayed at better houses.

The governor that is used for that purpose is of a single-acting type and actuates the feed mechanism in but one direction, which is all that is required for the purpose, but with a delicacy that results in "feeds" that average a combined movement of the carbons toward each other of one one-thousandth of an inch and causes a uniform potential to be maintained at the arc.

That machine doubtless is susceptible of other applications, but it is that same efficiency expressed in their recent development of a double-acting type that lends itself more readily to adoption in fields of industrial usefulness.

The entire machine in its present size is comparatively small, measuring about 6" x 7½" x 9". It is capable of operating a variety of other connected mechanisms, and may be direct connected to the apparatus to be governed. For heavy work it may be installed as a relay, accomplishing its work through its control of a motor or other source of power.

This controller may be classed as of the centrifugal governor type, but is, nevertheless, a distinct departure in design and in results, from any other device.



It has already demonstrated in actual practice its ability to govern the speed of a rotary converter, through a field rheostat, within one per cent of a pre-determined speed—meaning one-half of one per cent on either side of a neutral point, the said point remaining the same whether the generator is under no load or full load.

The control of speed and regulation of conditions are problems that this machine will solve in several lines, but those that suggest themselves most prominently, are turbine operation, hydraulics, textile manufacture, cold storage temperature regulation and electric arc welding.

It will deliver a continuous positive motion in either a forward or reverse direction to any connected valve, rheostat or other graduating device, as long as the controller is driven at a speed that is either above or below a given, adjusted for, neutral point.

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THE "SIMPLATE" VALVE—ITS CONSTRUCTION AND OPERATION

DURING the past decade, a number of designs of flat plate Compressor Valves have been presented and discarded because of inefficiency and impracticability. These designs were all remarkably similar, varying only in minor details.

The "Simplate," unlike any and all other valves is unique and distinctive in both design and construction. Its chief advantages are that it is simple; that its plates are independent in action, one of another; that each plate has its individual springs; that the tension of the spring on the inlet and discharge valves differs according to the density of the air handled; and lastly that it is applicable to all positions and conditions.

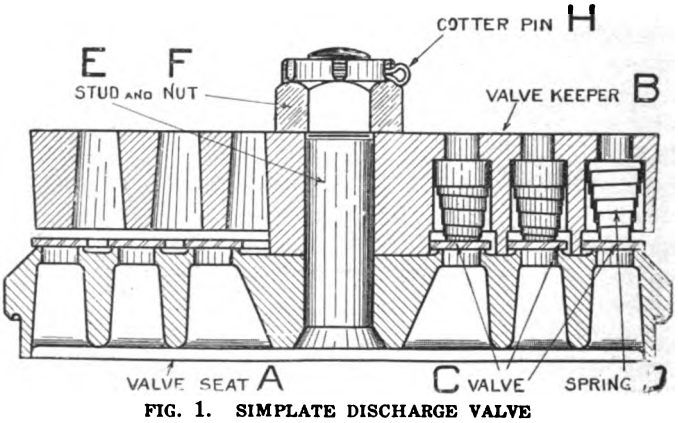

FIG. 1. SIMPLATE DISCHARGE VALVE

In the first figure we show a discharge valve. The valve seat is cast from a special composition possessing toughness and high tensile strength, and it also has circular ports as shown in the figure. It is machined so that the raised portion of the seat, or the points on which the plates rest forming the joint, is very narrow, thus reducing the unbalanced area to a minimum.

The keeper is of the same material, and is provided with suitable ports for the free passage of air through it. It also furnishes the guides for the valve plates, and affords, as well, satisfactory pockets for the valve springs.

The valves are simple concentric steel plates of uniform section, with a separate and independent plate over each port. Each plate is also independently governed by its own springs, hence the action or opening of each valve is entirely independent of the other. Should one of the plates open, the one next to it does not necessarily need to move, unless speed conditions should demand it. Here we see the great advantage of having the plates independent of one another, rather than for the series of plates to be made from one sheet with openings cut through to allow the air to flow from the different ports.

The springs are of the volute type and are made of special alloy steel, heat treated and carefully tempered. They have the proper tension for the discharge and inlet valves, so as to effect the most perfect valve action. The parts making up a complete valve are assembled and held together by a nickel steel stud and castle nut, and when this nut is securely tightened in place, it is firmly held so by a cotter pin.

The second figure shows the inlet valve, the construction of which, as can be seen, is very similar to that of the discharge valve. It differs only in the following respects: The valve stud enters through the keeper instead of through the seat, as does the discharge; the keeper is thinner; and the springs are of lighter tension. On account of the difference in the

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thickness of these valves, they cannot be reversed; that is, the inlet cannot be put in where the discharge should be, nor the discharge where the inlet belongs—this precautionary measure we deem to be highly necessary. We make the spring tension on the inlet valves very light so as to get the full benefit of the varied opening of the different plates when the piston speed is changed. For instance, with an inlet valve of the size here shown, the spring tension is so calibrated that the outer plate opens with a pressure of but ¼ ounce per square inch, and one ounce will open the intermediate plate, while it requires 2½ ounces to open the inner one. This illustrates the true meaning of the varied opening.

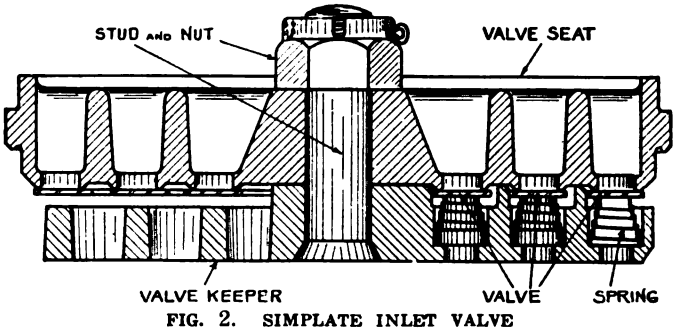

FIG. 2. SIMPLATE INLET VALVE

"Simplate" valves are efficient in the highest degree because, they are light and durable; always remain tight, are opened with little work; and are noiseless in operation. They have suitable spring tensions, inasmuch as the inlet and the discharge spring tensions differ according to the difference in the density of the air handled; their opening is varied in proportion to the increase or decrease in the piston speed; their location in the cylinder is convenient for examinations or repairs and allows the air to enter the cylinder through cool and unrestricted passages; and, finally, the power required to expel the air from a cylinder equipped with "Simplate" valves is a minimum.

"Simplate" valves are remarkably simple, since they have independent plates and springs, and a varied opening according to speed. At low speed one plate acts—at high speed all operate, hence the action is ideal under all speed conditions.

These valves are silent in operation at all speeds, resulting in little wear and long life; they are equally suited to high and low pressure; and the cost for repairs is reduced to a minimum.

They insure higher mechanical and volumetric efficiencies than the old style poppet valves; they insure continuous operation under the severest conditions; and the air compressing cylinders are simplified, due to the absence of all intricate valve operating mechanism. The valves require no lubrication; the compressor floor space and cost of installation are lessened because of the possibility of getting a greater capacity from a given machine when operated at high speed; and lastly, the valve parts, as well as all other parts entering into the complete unit, are perfectly interchangeable.

All "Simplate" Valve plates are made of a special alloy steel, heat treated, oil tempered, straightened perfectly and ground true on one side only. All valve plates are also rigidly inspected before assembling. Valve springs are made of high grade crucible steel, drawn at the proper temperature, and put through a series of rigid compression tests.

All parts entering into the construction of "Simplate" valves are of the highest quality and workmanship and the Chicago Pneumatic Tool Company, Chicago, Ill., guarantees to repair or replace free of charge any part which is found to be defective in workmanship or material in any "Simplate" valve plates within a period of one year after date of shipment.

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AMERICAN-MADE TRACING CLOTH

TO the National Tracing Cloth Company is due whatever credit there might have been in placing American-made tracing cloth on the market. For years American consumers were dependent on imported cloth—good, bad, and indifferent. Since the inception of the National Tracing Cloth Company about five years ago it is possible to get a cloth of American make, of superlative grade, and at a price considerably lower than the best imported brands, to which it is in no degree inferior.

National Tracing Cloth is made at Saylesville, R. I. The manufacturing plant is part of the Sayles' Bleacheries, itself a household word in the textile world, an alliance ensuring ample financial resources and an ability to "make good" in any commercial guaranty or contingency.

The essential features of a high grade Tracing cloth are translucency, erasive qualities and tensile strength. These are possessed by the "National" to a superlative degree. The first feature is instantly obvious to the observing eye; the second, is readily demonstrated by an efficient draftsman, and the bursting strength of the "National" is recorded in a Government test as 85 points—a record for Tracing cloth; and as to pinholes, the bugbear of the draftsman, they do not exist in the "National."

The Company started rightly by using a basic cloth of exceptional excellence as the foundation of its finished article, made from selected yarn of long staple, giving it a stability of character, both in material and finish, so desirable where a drafting department desires to file away its drawings for reference in after years.

The cloth is made in four widths,—26", 30", 36", and 42", put up in rolls of 24-yard lengths, and packed in cases of 25 rolls each.

Some years ago the Company put forward a proposition for the supply of cut and printed sheets in sizes required by users, and a highly specialized equipment for cutting and printing was installed in their plant, securin accuracy of dimensions, economy in cost of cutting and a minimum of waste of material. The printing is done with an ink especially made for use on tracing cloth and is characterized by its extreme density and its adaptability for the work. A schedule of sheet prices were drawn up based on the value of the cloth itself. The Company added no cost for the labor of cutting. The trade was prompt to recognize the advantages of this proposition offered to them, affording a welcome relief from the labor of sheet cutting. The popularity of the scheme has widened until it is now an important and increasing factor of the Company's business. All this tells for efficiency and economy and is in line with the commercial tendencies of the times.

As a result, the area of the business activities of the Company and the volume of its sales have been steadily increasing, and their product is now used in every center of manufacturing and industrial activities, by some of the leading railroads, and many of the U. S. Government departments.

Samples of National tracing cloth may be had by writing the National Tracing Cloth Co., Saylesville, R. I.

The Peffer Air Brake Hose Protector, as previously sold by the Railway Economy Device Company of Chicago, is now exclusively controlled by the Q and C Company, and will be known as the Q&C-Peffer Hose Protector.

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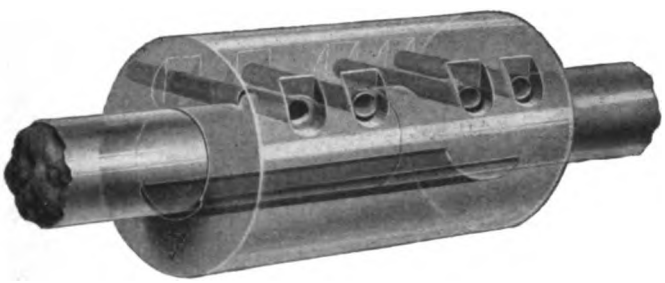
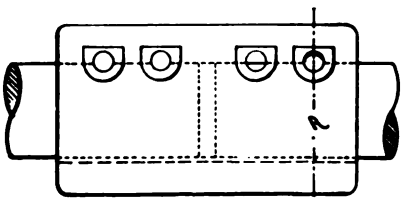
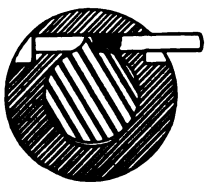
A SHAFT COUPLING

THE Thomas Patent System of Keying for shaft couplings, collars and clutches is the outgrowth of a need as seen by one who has been active in transmission work for many years and has realized the shortcomings of compression, keyway, and set screw methods. The illustrations of the coupling show clearly the Thomas principle.

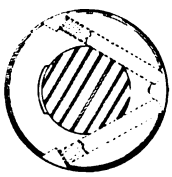


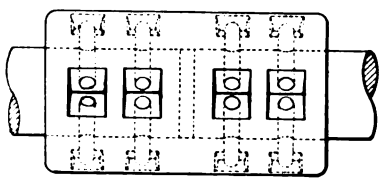
Of first importance is the safety feature. The construction is such that the coupling cannot be the cause of injury or accident, and it fully complies with the safety laws.





Utility is next for consideration. The shafting is not machined or prepared in any way, and old shafting with keyways can be used successfully. The coupling eliminates the expense of keyseating and fitting keys. The hardened steel pins are cupped in one end, making a cutting edge, and are finished a driving fit in the holes of the coupling. When attaching a coupling the pins are driven home with a hammer, cutting their way through the side of the shafting and becoming securely imbedded. The operation requires from two to six minutes according to the size of the coupling.





The coupling provides perfect alignment and greater strength than the shaft itself. Back lash and end thrust conditions will not loosen the grip even in the largest sizes where the most trouble is experienced with some couplings. Reduction couplings are made to suit any combination of sizes.

The price is moderate, due to the simplicity of the design and the cost of manufacture, making a third consideration of interest to every purchaser. The coupling happily combines safety, ease and cheapness of installation, absolute and permanent grip, and moderate first cost without expense for upkeep or repairs.

Several thousand of the couplings have been in use for a number of years, having passed the experimental stages.

The coupling is manufactured by the Thomas Coupling Co., at Troy, Pennsylvania, where a new modern plant has been placed in operation recently. Friction clutches and shaft collars are built also, using the same system of keying to the shaft. A new catalogue is ready for mailing.

An inquiry addressed to the Thomas Coupling Co., Troy, Pennsylvania, will bring information of high value.

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ENSIGN ELECTRIC CALCULATING MACHINE

THE simple adding machine is familiar to everyone, having become a part of the standard equipment of the large business office. There has long been wanted, of course, a machine which would go even further and carry on with equal or greater facility the additional functions of subtraction, multiplication and division. The Ensign Calculating Machine now offered has solved this problem. It is an automatic electrically-driven machine, which enables an operator without special experience or previous training to multiply, divide, add, or subtract, both rapidly and accurately. The control is entirely electric and automatic, there being no handles to turn, no levers to pull, and no key strokes to count. Its maximum capacity is 999,999,999 × 9,999,999 and gives the complete result to sixteen places. It has a "proof meter" which automatically registers a proof of the operation. The operator checks this proof and no other checking is necessary.

The Ensign Machine handles all functions of calculation rapidly by merely pressing the keys *once only* for each digit. It automatically clears the keyboard, proof meter, and result dials by touching one clearing lever once. It has an automatic electric drive as an integral part of the machine, automatically cutting off the electricity the instant the operator ceases to operate the machine. This insures against all loss from motor burn-outs or waste of current.

With the Ensign an experienced person can accurately and rapidly compute figures for engineering and industrial calculations, check extensions on invoices, compute payrolls, handle cost accounting and percentage figures, pro-rating, billing, inventories; in fact any work which involves multiplication, division, subtraction or addition.

The manufacturers of the Ensign Calculating Machine have such confidence in its ability to do your figuring rapidly, accurately, easily, and inexpensively, that they will place a machine with any responsible house on trial.

This machine is made by the Ensign Manufacturing Co., Faneuil District, Boston, Mass.

Steel Posts and Poles

THE CARBO STEEL POST COMPANY, Chicago, Ill., have issued a booklet describing "Carbo Steel Poles" for telephone, telegraph, trolley and transmission lines and signal service works. The Carbo Pole is radically different in design from any pole on the market and has attracted a great deal of attention from engineers who have shown much interest in it.

Power Chains and Sprockets

DIAMOND CHAIN & MFG. CO., 241 W. Georgia St., Indianapolis, Ind.—"Power Chains and Sprockets" an interesting treatise on transmission problems and contains many solutions for your chain and sprocket troubles.

Wagon and Truck Loaders

THE JEFFREY MFG. CO., Columbus, Ohio. —Bulletins Numbers 165 and 166. These bulletins describe in detail Jeffrey Standard Types of Loaders for Handling Coal, Coke, Crushed Stone, Sand, Gravel, Ashes and other loose materials. Heavier Types of Loaders for handling Bituminous Coal, Crushed Stone, etc., are self-propelling, easily operated by the ordinary yard laborer, and can be moved from pile to pile under their own power. The Light Weight Hand-Propelled Loader, and especially designed for handling Anthracite Coal, is equipped with a Feeder Attachment which pulls the coal into the buckets and eliminates the necessity of having a man on the pile to push the coal down. Fitted with Screen and Dust Hopper, and if desired, the latter is made in combination with a Bagger.

Lighting

THE HOLOPHANE WORKS, Cleveland, Ohio, have recently published "The Lighting Handbook" covering the general subject of illuminating engineering from the practical standpoint. The book contains, as well, elementary technical data on lighting and data on the engineering performance of the products which they manufacture.

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IMPROVED MACHINERY

NEW METHODS
NEW PROCESSES

NEW MATERIALS
NEW APPLIANCES

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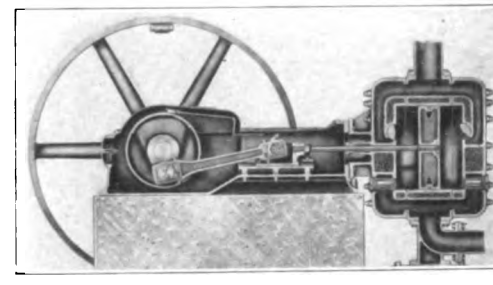
A NEW VACUUM PUMP

THE modern power house equipment invariably includes a condenser plant, the efficiency of which depends upon the degree of vacuum within the condensing apparatus. For maintaining this vacuum, and for general service in other lines where a high degree of vacuum is desired, the Ingersoll-Rand Company, 11 Broadway, New York, has recently introduced a complete line of steam and power driven, duplex type, "Imperial" Vacuum Pumps. In general design these machines follow that of the "Imperial" Air Compressors, a type with which engineers and power plant operators are long familiar.

The vacuum cylinders, as will be seen from the sectional illustration, are somewhat different from those ordinarily met with. The intake valves are of the Corliss type, so placed in the cylinder head that the clearance is exceptionally low. This is a desirable feature in that the air trapped in the clearance spaces at discharge pressure will not reach such a volume, upon being expanded to intake pressure, as to greatly limit the pressure reduction which may be obtained. The action of the valve is positive and quick and, its action being independent of the cylinder and intake pressures, the pressures within and without the cylinder are as nearly equal as possible.

The intake ports are large and direct, which together with the water jacketing of the valve tends to cool the intake gases.

The discharge valves, which are of the "direct lift" poppet type, are placed in the bottom of the cylinder heads so that any entrained moisture or water is immediately discharged, a



feature that makes for safety in handling moist or even saturated vapor. Clearance at the point of discharge has been reduced by making the valve partially fill the port in the cylinder head. The discharge passages are also water jacketed.

The cylinders are said by the manufacturer to meet fully the requirements of satisfactory and efficient operation. The air passages are unobstructed. Tie bolts pass from head to head and hold cylinder and heads tightly assembled. Both cylinder and heads are completely water jacketed, which is said to be an essential feature in the design of vacuum pumps, as the high ratios of compression tend to create high discharge pressures unless the heat is removed as generated.

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The unusually low clearance in "Imperial" Vacuum Pumps has been obtained, not by dangerously close piston clearance, but by the correct design of the valves and valve ports. Owing to the extremely low clearance, the complete water jacketing, the use of mechanically operated Corliss inlet valves and other refinements of design, the manufacturer guarantees the easy maintenance of a vacuum of within ½ inch of barometer.

The running gear, that is, the main frame with its enclosed reciprocating parts, the crank shaft, connecting rod, crosshead, valve gear and wheel on both belt and steam driven machines, are of the same design as the "Imperial" air compressor. Lubrication is by the bath system, providing automatic flood lubrication, yet retaining, by the removal of covers from the casing, all the points of accessibility of the open type of machine. When operating, the fly-wheel is practically the only visible moving part, yet the entire mechanism is readily accessible while in motion.

The Imperial Vacuum Pump occupies less floor space than similar capacity machines of the straight line type, due to its duplex construction and to the fact that its speed of operation is higher.

In reality a Duplex machine such as this, is two identical units of like capacity united by one common frame, with cranks at 90 degrees. This makes it possible, should requirements fall temporarily below that for which the equipment was originally installed, to remove one connecting rod and the operation of one half the machine discontinued, while the other half operates at its rated speed and hence at utmost efficiency, displacing, however, one half the vapor the entire machine is capable of handling.

These machines are built in capacities from 798-7,048 cubic feet per minute both for atmospheric and low pressure (5 lbs.) discharge.

The manufacturer claims for these vacuum pumps that they operate practically independent of attention, and are thoroughly efficient and economical machines for maintaining a high vacuum.

NELSON VALVES AT THE PANAMA-PACIFIC EXPOSITION

THE Nelson Valve Co., of Philadelphia, has on display at the Panama-Pacific Exposition an exhibit of valves which has attracted very favorable attention. Its most striking feature is a large revolving black velvet covered display stand, on which has been arranged a comprehensive assortment of brass valves of various kinds. Included among them are gate, globe, angle, swing check and non-return valves.

They have been mounted, so as to afford an excellent opportunity for a close and detailed examination of every feature.

In addition a number of sectioned valves of each kind are displayed, so that the internal design may be more easily explained.

The assortment of brass valves is supplemented by a number of larger iron body and steel body valves of various types.

The double disc feature of the Nelson Gate Valves has come in for a special amount of attention and explanation.

Mr. W. J. Marland has charge of the exhibit. He has succeeded, in conjunction with the company's San Francisco agent, Mr. W. H. Gilbert, in making the exhibit not only interesting, but actually instructive as well.

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IMPROVEMENTS TO "LEA" V-NOTCH METER INTEGRATOR

THE Yarnall-Waring Co. are now placing on the market a new and more heavily designed integrator, for use on their well known "Lea" V-Notch recording liquid meter.

In this new type, the aluminum dial, which drives the integrator counter, is in turn driven by means of a pendulum clock movement, built especially by the Seth Thomas Co. for this service. It has a double heavy spring pendulum movement, which is so constructed that vapor and dust do not seriously affect its accuracy.

It has been found in practice that it is advisable to use a separate clock mechanism for the operation of the integrator from the clock mechanism which operates the chart recording mechanism, for the reason that if either clock should be deranged in service the user still has the other clock record to depend upon. Hence it is impossible to interrupt the readings of the "Lea" meter.

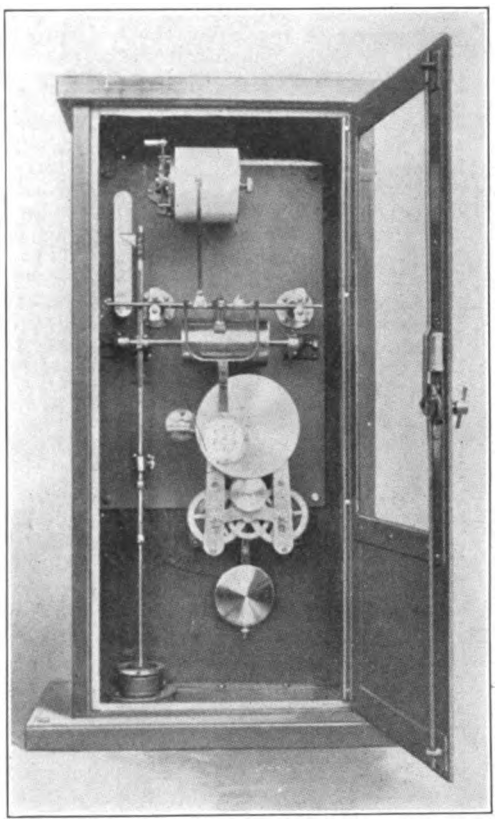
In addition to this advantage, it is found by using two clocks that one can be used as a check against the other, and in this way more dependably accurate results obtained.

The original "Lea" V-Notch instruments were built with hand screws for making adjustments. It has been found in practice that in a few instances in power plant service, vibration sometimes caused these thumb screws to loosen slightly. Hence, in the new model instrument, heavy screws with slotted heads have been used for making adjustments. A screw driver alone is needed for making such adjustments.

In the new type instrument, the pen arm adjustment has been simplified, also the yoke supporting counter dial on the integrator.

The case is so designed that the instrument cannot be affected in any way by steam or vapor getting into the instrument case, nor even by serious vibration.

The door of the case is equipped



with a tongue entering a felt-lined groove. A three way locking device jams the door against the felt, making practically an air tight joint.

All these improvements have resulted in a more sturdy and dependable instrument than the old type, which users everywhere found gave satisfaction.

Yarnall-Waring Co., 7622-30 Queen Street, Chestnut Hill, Philadelphia, Pa., will send fuller information on request.

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NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Cork Insert Pulleys

CORK INSERT CO., 164 Federal Street, Boston, Mass.—Booklet descries how discs of corks imbedded in the face of pulley cause the belt to hug the pulley with only normal tension and transmit full power, economically from the engine flywheel to the machine. This booklet illustrates various applications and proves their superiority. They have also issued in convenient book form reports of three important tests as follows: (1) Report of Efficiency Tests on Line Shafting Pulleys, made at the Worcester Polytechnic Institute, Worcester, Mass., by C. M. Allen, M. S., Worcester Polytechnic Institute, Worcester, Mass., and F. C. Furlow, M. E., Georgia School Technology, Atlanta, Ga.; (2) Report of Tests made by J. R. Nichols, under the supervision of Prof. Ira N. Hollis at Harvard University, Cambridge; and (3) Report of Efficiency Tests on Motor Pulleys, made at Lowell Textile School, Lowell, Mass., by George H. Perkins, S. B., Head of Engineering Department.

Electric Fans

B. F. STURTEVANT CO., Hyde Park, Mass.—Bulletin No. 221 describes the smaller sizes and types of Sturtevant motor-driven fans. The bulletin includes capacities, net prices, data covering pressures, volumes, sizes, etc., to guide in the selection of a small fan for any specific purpose.

Electric Monorail Cranes

SPRAGUE ELECTRIC WORKS OF GENERAL ELECTRIC CO., 527-531 West 34th Street, New York—Bulletin C-7 shows how delays are eliminated and the output of your production increased by the installation of Sprague Electric Monorail Cranes.

Feed Water Heaters

NATIONAL PIPE BENDING COMPANY, 72 River Street, New Haven, Conn.—The unique features of contact pipes are shown; also the advantages of upward filtration and other details of the National Direct Contact Feed Water Heaters in Catalog No. 2.

Electric Hoists

MARIS BROS., Philadelphia, Pa.—Bulletin No. 51, fully describing the Maris Electric Hoist and telling of its special features. This hoist is especially adapted for foundry use and where smooth, accurate work and absolute control is necessary.

Force Feed Lubricators

THE RICHARDSON-PHENIX COMPANY of Milwaukee, Wis., recently issued Bulletin No. 50—The Phenix Force Feed Lubricator, contains a complete description of the Phenix ratchet type lubricator; it also describes a new type, known as the Model "T". The catalog contains an interesting diagram, giving a comparison of the way in which mechanical and hydrostatic lubricators feed oil to engine cylinders. Numerous illustrations show the application of the Phenix Lubricator to different types of engines, pumps, steam hammers, etc.

Metering Heaters, Recorders, Etc.

HARRISON SAFETY BOILER WORKS, 17th and Allegheny Ave., Philadelphia, Pa.—"Finding and Stopping Waste in Modern Boiler Rooms" is the title of a 68-page book devoted to use and design of Cochrane Meters. The value of feed water and condensate meters as an aid in the management of the power plant is taken up in detail, covering among other factors, grade of fuel, grates, methods of firing, air leaks, control of draft, etc. The Cochrane Metering Heater (Combined Open Feed Water Heater and Hot Water Meter) with its several modifications is described in detail, as also the Cochrane Flow Recorder in connection with V-notch weirs. This book would be of advantage to those who are on the lookout for information covering the scientific management of the steam plant.

Motor Trucks

PIERCE-ARROW MOTOR CAR CO., Buffalo, N. Y., have recently published a booklet "What Pierce-Arrow Motor Trucks Are Doing in the Contracting Business" which contains many interesting details of costs, loading facilities, etc. This booklet will be a great value to any contractor.

Recording Gauges

THE FOXBORO CO., Foxboro, Mass.—Bulletin No. 98 illustrates and describes Foxboro Improved Recording Gauges for all purposes. Several new and important improvements are for the first time illustrated and described. There are also illustrated several typical and interesting records from the Recorders in actual service.

Water Lifted by Compressed Air

INGERSOLL-RAND CO., 11 Broadway, New York, N. Y., have issued two new booklets, Nos. 76 and 9201. No. 76 is an 80 page catalog, subject—"Water Lifted by Compressed Air." A complete treatise on the Air Lift and explains in detail the Air Lift System of Pumping. To all those in any way interested in adequate water supply, a copy of this booklet will be found invaluable.

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IMPROVED MACHINERY

NEW METHODS
NEW PROCESSES

NEW MATERIALS
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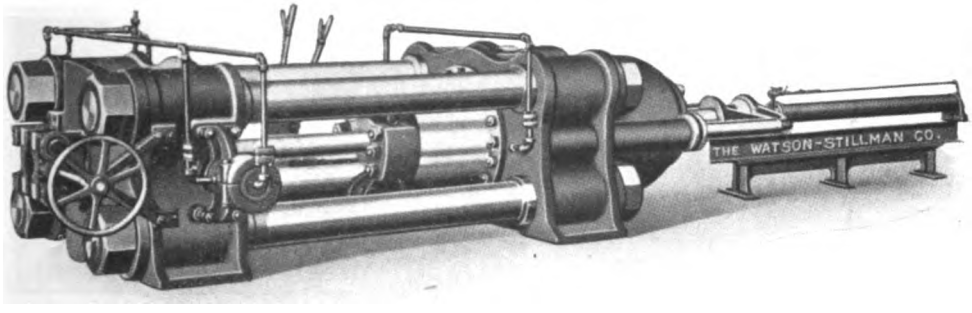
THE EXTRUSION METHOD IN SHAPING METALS

THE manufacture of rods, rod-shapes, angles, tees, etc., by rolls or by drawing through dies is familiar to most every one dealing in nonferrous metals. But the production of these forms and shapes by the extrusion method, in which the heated billet or slug is pushed, not drawn, through dies by hydraulic pressure has many features of unusual interest, both in the construction of the press, manner of operation, and the uniformity and density of the texture of the finished product.



The machine illustrated herewith is one of the line of The Watson-Stillman Company, 54 Church Street, New York, designed to extrude copper, brass, aluminum, alloys, or any nonferrous metal, and has a capacity of approximately 850 cubic inches of metal per stroke of ram.

By referring to the illustration, it will be seen that the press consists essentially of a main cylinder and plunger, a die holder or platen, and a billet container. A hot bed for receiving and straightening the rods is shown in Fig. 2.

The operation of the press is as follows: The billet container is preheated and then attached to the platen by male and female connections, so that the metal cannot escape except through the dies. A hot slug or billet is then transferred to the slug carrier which is in line with the billet container. The billet is then pushed out of the slug carrier into the billet container by a rod running through the main ram and operated by an air cylinder shown at the back end of the press. This rod is then withdrawn and the plunger, which is made of a special steel to resist the heat and take the full 2,000 tons pressure exerted on the ram, is dropped in front and becomes a part of the ram.

Pressure is then applied to the main ram, which forces the plunger into the billet container, thus forcing the metal out of the container through the dies and on to the hot bed. The

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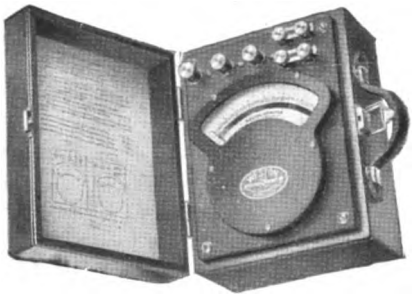
dies are then cleared and the plunger pulled back by means of pull back cylinders shown at either side of the main cylinder, and is ready for a new billet. The movements of the rams are governed by a set of specially designed operating valves which are controlled by pilot valves at the side of the press.

The press has a capacity of 2,000 tons pressure on the plunger, and works at 5,000 lbs. operating pressure from either accumulator or direct pump line.

The overall dimensions of the press, without the hot bed, are 30 ft. in length, 12 ft. in width, and 6 ft. in height; the length of the hot bed and runway is 40 ft., making the total length of the assembled machine 70 ft.

NEW WESTON A. C. INSTRUMENTS

PROBLEMS hitherto considered impossible of solution have been solved in the designing of A. C. instruments by the Weston Electrical Instrument Co., 31 Weston Ave., Newark, N. J. They are the latest development of instruments of this type and embody characteristics never before attained.



The new portable A. C. and D. C. electrodynamometer ammeters are ammeters of precision adapted to use on A. C. or D. C. circuits. They are guaranteed to an accuracy of ¼ of 1 per cent full scale value on either D. C. or A. C. circuits of any frequency to 133 cycles per second and any wave form. They can be used on circuits of any commercial frequency as high as 500 cycles per second without error. Double ranges are furnished in this model.

Their movable systems have an extremely low moment of inertia and are very effectively damped. Indications are independent of room temperature, the heating effect of current passing through the coils, and the instruments are shielded from external magnetic fields.

The scales are 5¼ inches long. Owing to the principle of operation these instruments cannot be made with scales uniform throughout their entire length, but the upper 4/5 portion of the scale is remarkably equalized. Each scale is hand calibrated and is provided with a mirror over which the knife-edge pointer travels and the pointers are equipped with a simple zero setting device.

For complete information regarding Model 370 write for Bulletin No. 2003. Other models in this group are Model 341 A. C. and D. C. Portable Ammeter described in Bulletin No. 2004; Model 310 Single Phase Portable Wattmeter and Model 329 Polyphase D. C. Portable Wattmeter described in Bulletin 2002.

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A New Electric Air Heater and Blower

THERE has long been an urgent need for a small electric air heater and blower. Such an apparatus has recently been put on the market, which consists of a small motor-driven fan discharging air through heating coils placed in an aluminum casing. The forced circulation renders it possible to deliver a large volume of hot air in a short time. The apparatus is readily portable and can be used in connection with any wiring system.

The set is made in five different sizes, and it delivers air at one, two or three temperatures depending on the size. The fan outlet can be turned readily so as to discharge in any direction. The switch mounted on the base has different positions and the temperature of the air delivered depends upon the position to which the switch is turned. Handle for carrying can be seen in illustration.

This little heat and air blower can be used in factories and manufacturing establishments; the unit has a wide field of uses for drying products and manufactured articles. Artificial drying will often increase the output. It is also used for blowing furnaces, ventilating and heating rooms, small theatres, halls, schools, etc.

This electric heater and blower is

manufactured by the B. F. Sturtevant Co., Hyde Park, Boston, Mass., U. S. A. A catalogue is ready for mailing, and contains detailed information of high value to those who may have use for such an apparatus.

Seventy Years of Successful Business

THE Tuttle & Bailey Mfg. Co., of No. 52 Vanderbilt Avenue, New York City, are closing their seventieth year in the continuous manufacture of Registers, Ventilators and Grills.

Beginning modestly with a small factory in Brooklyn, they have enlarged their business to cover nearly two city blocks, which they now own, together with the modern four to eight story factory buildings situated thereon. Besides operating branch offices in Boston, Chicago and Cleveland, they have recently completed a Canadian factory at Bridgeburg, Ont.

For quality of material and workmanship no concern has enjoyed greater favor among Architects and the trade than this company. In a large percentage of specifications their goods are specified outright, while the frequent use of the term, "Tuttle & Bailey Make, or equal," indicates their product to be the standard of comparison. Hardly a new building is erected which does not contain their products.

In the manufacture of Metal Parts they are exceptionally well equipped for finishing in Black or White Japan or Electro Plating of any kind. A large iron foundry and brass foundry adjoining are continually in operation, where the most modern methods tending toward economy and excellence of production are employed in producing a superior output.

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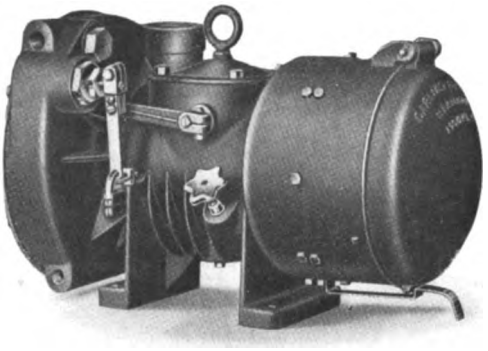
BRILLIANT HEAD-LIGHTS FOR LOCOMOTIVES

THE remarkable development in head-lights for automobiles is now rapidly arousing railroad engineers and officials to the paramount necessity for a like development in locomotive head-lights. Many of the officials of our leading railroad systems have already put their experts at work on the problem and within a short time the Interstate Commerce Commission is expected to



make a new ruling which will go far towards quick development in this new science and means of preventing accidents.

In view of this development, the Buff & Buff Manufacturing Co. of Boston, who for years past have been among our foremost manufacturers of surveying instruments, have had their experts busily at work for a long time past in perfecting a new locomotive head-light and generator, which embodies all the latest novelties and advances in the science.

The turbine of this head-light is designed for low steam consumption and to give a light of full intensity on low steam pressure. All wearing surfaces are renewable at minimum expense and interchangeability of like parts is obtained by the use of efficient tools and careful inspection.

The generator will stand considerable overload. The wiring is simple, accessible and easily understood. The generator is compound wound thus making it possible to use cab lights and classification lights in conjunction with or independent of the light at the head of the engine.

A new bulletin illustrating and describing the apparatus in detail will be found interesting to railroad engineers and officials, and it may be had on application to the Darling-Henrici Mfg. Co., Mattapan, Boston, Mass.

COSTS REDUCED BY USING CORK INSERT PULLEY

THE saving in the cost of power transmission which is sometimes possible at comparatively slight expense is strikingly shown by the experience of a New England wire manufacturer on the main drive from a 1,400 horse power engine which operates one section of the plant. The flywheel is 24 feet in diameter, the receiving pulley only 53 in., the distances on centers 40 feet, and the belt speed 5,700 feet per minute. With a 56 in. triple belt, the widest that could be used, running on a cast iron receiving pulley the overload was so heavy that a belt tightener had to be used to carry even an approximately full load. This put such a strain on the belt that its life was only about two years and during a good part of that time there was constant danger of its giving out unexpectedly and shutting down a whole section of the plant, until it could be repaired, which actually happened more than once.

In 1911 after study of the problem had reduced the methods of handling it to two—a rope drive or Cork Inserts—the record made at the Amoskeag Manufacturing Co. of Manchester, N. H., where they had been most

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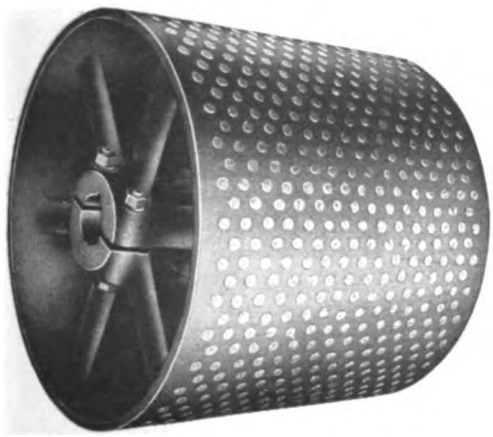
extensively used, and elsewhere resulted in a decision in favor of Cork Inserts. The plain iron receiving pulley was replaced by a specially designed Cork Insert pulley, similar to the one illustrated, of the same size, the binder was removed and a com-



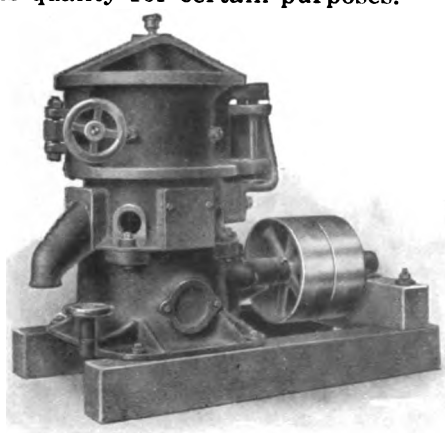
paratively slack belt put on. The results justified every expectation. Even when conditions were at their worst the belt pulled the full load without excessive slip and has been doing it ever since at a very low upkeep cost. Even allowing $2,000 for a new belt there was a saving of $3,400 over the cost of the rope drive.

This saving was possible because of the great frictional efficiency of the Cork Inserts, the small discs of cork imbedded in the face of the pulley, their ability to maintain it even when there is excessive dampness or dust, which cause such serious losses with plain pulleys, and the great durability resulting from the method used in applying.

Descriptive matter, reports of tests to determine the comparative efficiency of the different types of pulleys in general use and information regarding the applicability of Cork Inserts to drives of any sort may be obtained from the manufacturers of these pulleys, The Cork Insert Co., 164 Federal St., Boston, Mass.

PURCHASING COAL BY ANALYSIS

FOR many years coal has been purchased from a given locality or a well known vein on its reputation as a heat producer or for its quality for certain purposes.



Scientific management has at last, however, opened the eyes of many engineers in charge of large power plants to such an extent that coal for these plants is no longer bought on its reputation but upon its merit alone. It is required to produce just so many heat units per dollar of cost, and if it fails to do so a rebate from the producer is demanded and obtained.

There need be no more guess work, by the well informed, in buying coal than in the purchase of iron and steel, nor should there be. We all are entitled to know and to get what we pay for and by the careful sampling and analysis of coal shipments both buyer and seller get all they have a right to expect.

The Government has for many years practiced this method of buying (on a B. T. U. basis) for its various departments and institutions, as have also many public service corporations, municipalities and private enterprises using coal in quantity.

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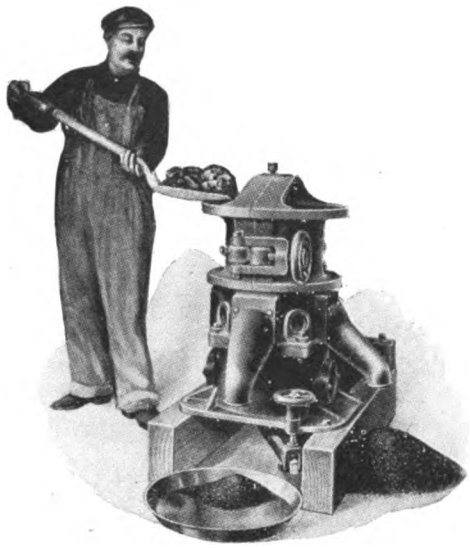
They have found it to be a good investment.

The process of sampling in the past has been tedious, costly, inaccurate



and not altogether satisfactory, in fact, many concerns have failed to adopt it for these very reasons, but now there is no such excuse, for a machine is built which crushes the coal at the rate of 3,000 lbs. per hour, and at the same time automatically extracts an accurate sample varying as desired from 5 to 15 per cent of the total amount passed through it, delivering the product ¼ in. and finer ready for the chemist to analyze. Thus all hand labor has been eliminated with the exception of collecting the samples. It is now only necessary to gather fair samples of a shipment, pass them through the Automatic Crusher and Sampler and the result, a small accurate sample of the whole is delivered in perfect condition for analysis. The result of such analysis determines the value and therefor the purchase price of all the coal in that shipment.

This simple little machine is shown in the accompanying illustrations and further particulars may be obtained from its manufacturers, The Sturtevant Mill Co., Harrison Square, Boston, Mass.

Motion Picture Publicity

THERE are three kinds of audiences to which the manufacturer tries to tell his story: First, the general public; second, a particular class; third, the individual. A very effective method of telling his story to each of these is by motion pictures. No story is too intricate or too simple to be told in this modern way.

The successful advertiser has recognized the importance of taking the public into his confidence. Many progressive companies have invited the public to visit their plants and have a first hand view of the honesty of manufacturing processes and the stability of their organizations. The leading companies which are now doing this are: H. J. Heinz & Co., National Cash Register Co., Sears-Roebuck & Co., and The Curtis Publishing Co.

Hundreds of thousands of advertisers are showing photographs of their plants and activities in the newspaper, magazine, car card, poster and other forms of advertising. Thousands of dollars are being spent in booklets that describe manufacturing processes, for distribution to the public. All of these advertisers are striving to create that necessary confidence.

A trip through a manufacturing plant showing the receipt of the raw material and following each step until the product is finished, sold and even put to use, can be made by means of a motion picture quite as effectively as an actual visit. It costs about as much for guide serv-

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SMITHING CIRCULAR SAW

ice in one plant for one year as it would to have a motion picture made and distributed. One manufacturer has twenty prints of his film in constant circulation and millions of people in one year will see his plant.

When the manufacturer has to deal with a particular class he can get the people to go to see the motion pictures when they cannot otherwist be appealed to. Films can be shown at local, county, state and national conventions with telling effect.

In telling the story to an individual, the proposition can be made up into a film, a duplicate turned over to the salesman who, equipped with a small projecting machine that can be carried, goes right into his prospect's office, pulls down the shade and tells his animated story on the wall. This is not a theory; it is in successful operation by a great many progressive companies. Aside from the fact that such a plan means a manufacturer does not have to concern himself about the kind of a story his representative is going to tell, as he has already planned this in the motion picture—he has the advantage of knowing that his salesman will have a much greater opportunity to secure an audience with prospects than his competitor who does not use the motion picture. Can you imagine a purchasing agent refusing to see a salesman who will present his proposition in motion pictures?

The demand on the part of educational, business and recreational institutions for pictures of this kind is much greater than the supply. All that is necessary to have such a picture shown, is to exclude any class advertising. Several bureaus that book these films have been organized and the expense of distribution is almost negligible.

One of the prominent companies

ABOVE: DEVELOPING NEGATIVES
BELOW: HAND ETCHING

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who are doing this work is The Dyer Film Co., 200 Fifth Avenue, New York, N. Y. They will be glad to furnish complete information to anyone interested in this style of sales promotion.

INDUSTRIAL NEWS NOTES

Mr. W. E. S. Dyer has been retained as Mill Engineer and Architect by Thomas Wolstenholme's Sons & Co. for a new Mill and Power Plant to be erected at Frankfort Avenue & Westmoreland Street, Philadelphia, Pa.

The name, Holophane Works of General Electric Company was changed on January 1, 1916, to Ivanhoe-Regent Works of General Electric Company.

This change was made necessary by the expiration on that date of the contract through which the General Electric Company possessed exclusive right to manufacture and sell Holophane prismatic glass.

The General Electric Company will continue to manufacture and sell Regent glass and Ivanhoe metal reflectors; and although its right to handle Holophane prismatic is no longer an exclusive one, it will continue to furnish this line also.

In its organization the Ivanhoe-Regent Works of General Elecric Company is in every respect the same as that hitherto known by the name of Holophane Works of General Electric Company.

The Stewart Engineering Corporation, 17 Battery Plcae, New York, N. Y., have been awarded the general contract for the construction of reinforced concrete foundations and retaining walls for the residence of Mr. Otto H. Kahn at Cold Spring Harbor, Long Island. The contract price is about $150,000.

Messrs. Delano & Aldrich, 4 East 39th Street, New York City, are the architects. The work is now under way.

The Spray Engineering Co., 93 Federal Street, Boston, manufacturers of Spray Cooling Sytems, have adopted the distinctive trade name of "Spraco" to be used in connection with their various products.

They have likewise adopted a very unique trade mark design consisting of the globe held in suspension by the spray from a "Spraco" nozzle; flanked by the words "Spraco Products."

This trade mark will hereafter appear on all Spraco equipment: "Spraco" Air Washers, "Spraco" Nozzles, "Spraco" Cooling Systems, etc.

NEW CATALOGUES

Water Wheel

THE PELTON WATER WHEEL CO., San Francisco, Cal., has issued a pamphlet in Spanish, Portuguese and English. It is of particular interest to engineers located in remote districts where electric energy is not available.

Turbines

THE TERRY STEAM TURBINE CO., Hartford, Conn."The Terry Turbine" is the title of a new bulletin just issued by this Company, giving a general description of the various turbine applications, and dealing particularly with various kinds of high, low and mixed pressure turbines.

Valves

THE WM. POWELL CO., Cincinnati, Ohio, have issued a 20 page booklet on their "White Star Valve." This book briefly, but completely, discusses the function of these valves, and illustrates in sectional views the several types. The booklet contains full information as to construction, operation and prices.

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IMPROVED MACHINERY

NEW METHODS
NEW PROCESSES

NEW MATERIALS
NEW APPLIANCES

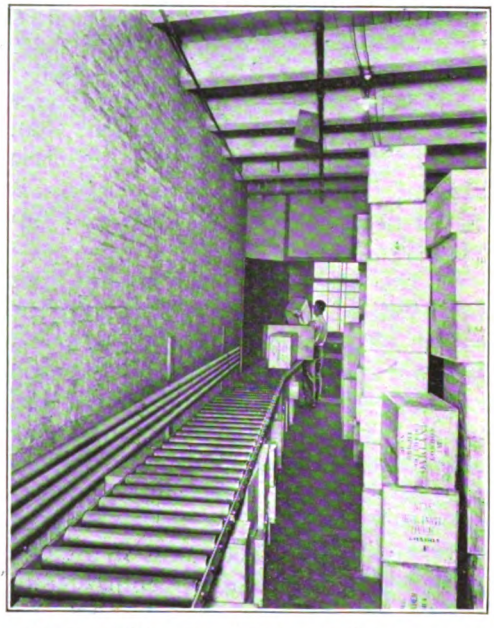
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

MOVING GOODS BY GRAVITY

ANYONE familiar with factory problems, who has coasted down hill in an automobile or on a bicycle, must often have wondered why the force that enables him to glide down a very slight grade at high speed could not be applied to moving the multitude of boxes, barrels and other packages that are met with in factories, warehouses and other industrial plants.

This is exactly what has been done by the gravity roller conveyor, upon which any package of regular shape may be carried from place to place by the force of gravity alone, without the consumption of any power and with no care or attention. The gravity conveyor reverses the condition of the bicycle traveling down a smooth road, as it contains within itself the smoothly running wheels upon which the packages glide.

The gravity conveyor system supplies one of the best solutions of the commodity handling problem in industrial establishments, as it requires no power and it is always ready to accommodate a load. The great saving in labor and breakage of packages and contents, and the rapidity with which boxes, cases and barrels can be handled by gravity, means a decided saving in the cost of transportation as compared with the old method of handling packages on trucks. One of the greatest advantages of the gravity conveyor is its flexibility. By means of curves, switches and other appliances, the conveyors may be run around corners, through partitions and floors, and may be laid out practically wherever desired.



One of the most interesting examples of the efficiency of the Gravity Roller Conveyor is that installed by The Lamson Co., 102 Boylston street, Boston, Mass., in the warehouse of the S. B. Thing & Co.

The conveyor is used to connect a ware-room on the third floor of their building with the elevator on the second floor. Before adopting the Conveyor, the boxes were sent down a wooden chute, from which point they

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were trucked about 200 feet on small hand trucks to the elevator. As a consequence, many boxes were broken and much time was wasted in merely carrying goods from place to place.

Under the present method, with the Lamson Gravity Conveyor, packages are merely placed in an iron chute connecting with the Gravity Conveyor, which conveys them, with no care or attention, to the elevator.

In addition to enabling the S. B. Thing & Company to put three porters on more profitable work, this installation has relieved the congestion which used to occur at the foot of the chute and near the elevator, as the Gravity Conveyor can hold in storage a large number of boxes ready to be removed at the discharge end.

Further information concerning the Lamson Carrier Service will be gladly furnished by The Lamson Co., 102 Boylston street, Boston, Mass.

THE ELECTRIC DRIVE OF CONTRACTORS' MACHINERY

THE electric motor is being used more extensively every year for operating contractors' machinery, such as hoists, concrete mixers, pumps, air compressors, shovels, etc.

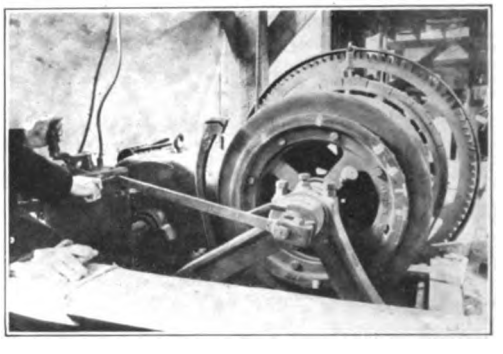
The reason for this growing popularity is simply that electric drive is more economical and convenient than steam, provided, of course, electric current is available, as it usually is in the neighborhood of built-up communities.

In the first place, the motor does away with the steam engine and the boiler. This means that there is no fuel or water to handle, no licensed engineer is required, and smoke and sparks are eliminated. One man only is required to handle a motor-driven machine, and he need not be an experienced engineer, as any workman can learn to handle a motor in a short time. A single handle controls all operations, starting, stopping, reversing, and changing the speed. The motor uses power only when actually running, and when at rest involves no expense whatever.

The Westinghouse Electric & Mfg. Company has studied this field very carefully, and builds a line of motors specially adapted for contractors' use. Their special features are their ruggedness and strength to withstand the very hard usage to which they are subjected.

Motors for hoists, concrete mixers, and shovels may be totally enclosed. They are designed to produce considerable power within limited dimensions, especially in starting, where the demand for power is greatest. The speed is adjustable, and the motor can be stopped and reversed almost instantly without injury.

The extensive use of electric power



in such operations as the building of the Panama Canal and the Catskill Aqueduct proves its desirability for large work, while a careful consideration of the advantages enumerated above makes it evident that it is a superior form of power for the small job as well as the large one.

The motor-driven hoist shown in the accompanying illustration is located on the sidewalk at 5th ave. and 14th st., New York City, where it is in use in connection with repairs to a building. This is typical of the

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many uses to which electric motor hoist is applicable where the steam hoist would be unsuitable on account of lack of space.

A more complete description of this motor-driven hoist may be had upon application to the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

Recent Advances in Blasting Methods

As in everything else, great advances have been made in recent years in the use and application of explosives for blasting purposes. It is not so very long ago that the only blasting agent known was blasting powder. Then came dynamite, crude and dangerous at first and timorously used until now we have the relatively safe modern high explosive called "Dynamite."

In blasting operations, a few years back, no one deemed it necessary or advisable to explode several charges of explosives simultaneously. Then the charges were small and even if there were several to be detonated, it was believed safer and more economical to explode each charge separately. To do this, fuse and blasting caps were used. After the charge of explosives was loaded in the bore hole, the fuse lighted and then a nervous wait ensued before the blast was made, one never feeling sure just when it would go.

How differently blasts are made today! While in former times small charges were the rule, it is not uncommon to have blasts in quarries or other rock excavations in which 40,000 lbs. or more of explosives are used. The holes may be from 30 ft. to 160 ft. deep. Increased demand for crushed stone, created by the desire for good roads, concrete construction,—R. R. expansion, etc., has demanded volume in production and brought about the Steam Shovel, mammoth crushers and "well drill."

The charges of explosives in the bore holes are larger and there are more holes to detonate. It is known that when several charges are detonated at the same time, they assist each other and consequently it is possible to use less explosives per hole or ton of material.

The detonating of many charges of explosives at one time is made possible by the use of electricity. This also makes blasting operations safer because one knows exactly when the blast is to occur and it can be made when everyone is in a safe place.

While electric firing is now generally used to detonate explosives in quarries, railroad construction and tunnel driving, it is not so much in general use in the coal and metal mines. It would seem that miners, because of the many dangers of their occupation, would be more anxious than any other class to adopt this safe and sure method of detonating explosives. In underground operations it is necessary to maintain as far as possible pure air for the workmen. Fumes from explosives when detonated are bad enough, but when the explosives are fired by blasting cap and fuse, the amount of smoke is greatly increased due to the burning fuse. This means the loss of a great deal of time waiting for the smoke to clear.

According to the U. S. Bureau of Mines, electricity is safer, quicker, more efficient, more certain and cheaper than any other means of set-

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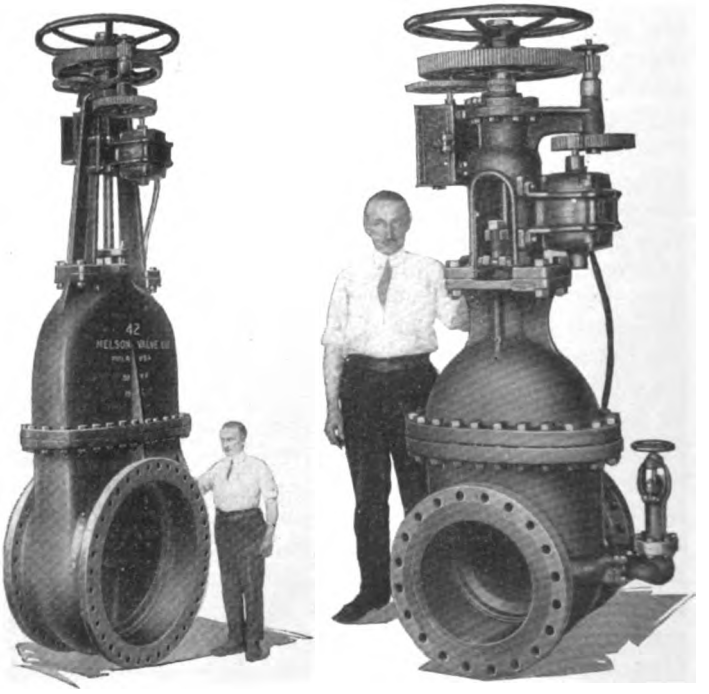
ting off blasts. Wet holes can be fired more easily by electricity than any other. The danger of igniting gas and coal dust from the spit of tne fuse is eliminated. Sparks cannot fall on the charge of an electric blasting cap and cause an explosion.

When electric firing is used the shots can be exploded while the person who is firing them is at a safe distance. The explosion follows immediately after the lever or switch has been thrown; there is no waiting as there is in firing by a fuse of squib and misfires and hang fires are rare.

The E. I. DuPont de Nemours & Co., Wilmington, Del., manufacture this complete up-to-date apparatus for "electrical firing" and will furnish further information upon request.

HUGE VALVES FOR THE PHILADELPHIA ELECTRIC COMPANY

THE Nelson Valve Company has recently completed a portion of their contract for supplying the valves which are to be used throughout the new station of the Philadelphia Electric Company, of Philadelphia, Pa. Included in the installation will be valves of practically every kind, from the smallest brass, gate and globe valves to huge 42-inch solid wedge iron gate valves like those shown in the illustration.



These enormous valves stand 14 feet high, and two of them weigh as much as an average size steam road roller. In all there are to be seven of these valves installed.

When installed in the Philadelphia Electric Company's Christian Street station, they will be operated from central panels on the turbine operating floor, which is 50 feet above the condenser pit floor line.

Operating conditions call for 80 pounds working pressure.

The valves have a steel clutch for disengaging the motor, if it is desired to operate the valves by hand. The design is such, however, that hand operation drives the limit switch at all times, so that if the motor is thrown into operation when the valve is partly open, the limit switch is in the proper position for starting the motor, and throws out the automatic circuit breaker on the control panel at the proper closing point of the valve disc.

There is a lost motion device between the stem unit and the large operating gear, for the purpose of giving a hammer blow effect to break the seat of the valve, in the event of scale causing the wedge to adhere to the seat of the valve. The motor is

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designed, however, of ample torque to open the valve without this hammer blow effect.

One characteristic feature of the valves is the high condensing chamber and deep stuffing box, such as is used in Nelson Valves for superheated steam service. The condensing chamber, being located between the stuffing box and the inside of the bonnet, insures longer life of packing, and safety in renewing the packing.

In addition to the 42-inch valves, seven 16-inch gate valves have been built and sent to the Philadelphia Electric Co. These valves are made for superheated steam working pressure up to 250 pounds, and for a total temperature of 800 degrees F. Each valve has been tested to 800 pounds.

The Nelson Valve Co., Philadelphia, Pa., will be glad to furnish information to anyone interested in these valves.

TEMPERATURE CONTROL FROM A CENTRAL STATION

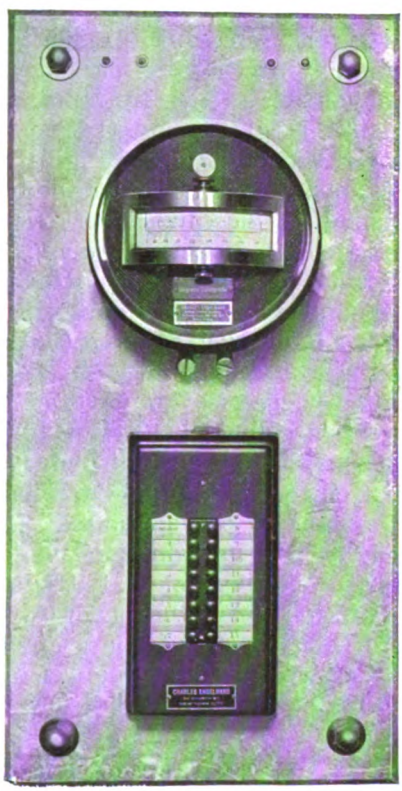
THE problem of accurate, practical and convenient temperature control within a wide range is made simple by Heraeus Resistance Thermometers. With them it is now possible to measure the temperature at any number of points from a central location with an accuracy closer than it is possible to read.

Resistance Thermometers should not be confused with Thermo-Electric Pyrometers for their principle and adaptability to conditions are entirely different.

The practical use of Resistance Thermometers covers the entire range from 373 deg. F. up to 1,300 deg. F. for refrigeration, in ice machines, distributing lines, cold rooms, etc., up through the range for heating and ventilation, kiln drying, chemical manufacturing, power plants, in feed water, condensers superheated steam and flue gases in enamelling ovens, steel tempering and in fact for any purpose where temperatures do not continuously exceed 1,300 deg. F., these instruments possess exceptional qualities.

They can be obtained for permanent installation with either indicating or recording instruments of switchboard types or in portable form, light, compact, and convenient.

The principle of operation is that of measuring heat by its effect on the resistance spiral. The electrical resistance of platinum as is well known varies with its temperature therefore the resistance of the platinum spiral is a direct indication of the temperature. To measure this resistance



the wheat stone bridge method is employed, the galvanometer of which is the indicating or recording instrument of the system.

These may be graduated directly in degrees of temperature. The scale of

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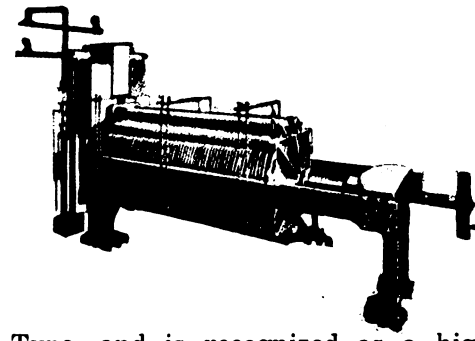
the indicating or recording instrument may be graduated between any desired temperature limits within the range of the thermometers. They can be provided with two or more scales where the range to be covered is too great to allow the desired accuracy in reading. The practicability and desirability of such a system will appeal to all those who have occasion to use such instruments.

Detailed information and literature can be obtained from Charles Engelhard, No. 30 Church Street, New York, whose name in connection with Heraeus Le Chatelier Pyrometers has become well known as an authority on pyrometers.

A New Machine for Making Pure Oxygen & Hydrogen

THE demand for Oxygen and Hydrogen for various industrial uses has grown very rapidly in the last five years. Certain lines of manufacture have been built up based on the Oxygen process of welding, such as welded tanks, steel barrels, automobile parts, tubes, etc., while for repairing broken machinery, for reclaiming castings, for metal cutting of every nature, Oxygen and Hydrogen or Oxygen and Acetylene are used in steel mills, railroad shops, foundries and down to the smallest machine shop. Hydrogen likewise is in active demand; it is used more and more for cutting purposes and for light welding; it is also used for lead burning platinum smelting, in the manufacture of filaments for electric lamps; and to a very great extent in the new industry of hardening oils by the hydrogenation process. This rapid development in the uses of two gases was facilitated by the introduction into this country of Oxygen and Hydrogen generating apparatus several years ago. Large users of one or both of these gases were thus enabled to obtain their supply direct from their own generating plant at low cost, in a manner suitable to their individual requirements.

The type of machine manufactured by the International Oxygen Company is known as the I. O. C. Unit



Type, and is recognized as a high class apparatus and is in successful operation in numerous plants throughout the country. Today, the International Oxygen Company is bringing out a new style of Oxygen and Hydrogen generator under the name of the I. O. C. Bipolar generator.

Further information describing this new oxygen and hydrogen generator will be furnished upon request by the International Oxygen Co., 115 Broadway, New York City.

The Calf Paths of Business

"AROUND Robin Hood's barn" and "crooked as a calf path" are phrases used by us often enough in daily life, and always with a smile at the man who pursues the tortuous ways symbolized by these common expressions.

We readily see the short cuts in the small acts of daily life, such as cutting corners when walking or driving; but so many of us, however, do not realize that in our business

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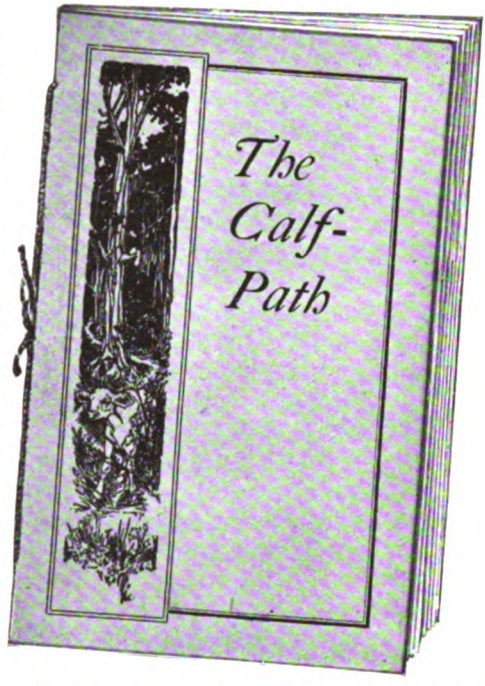
methods we are following calf paths that lead around Robin Hood's barn. Instead of following the broad highway, our work and our thoughts wander off into the by-paths and we loiter along, losing both time and the opportunity to arrive promptly at our destination. This is not confined to our personal acts, but is particularly noticeable in the travel of work through our factories, and in the indirectness of our accounting and costing work. We allow work in our shops to wander off into the calf paths of wasted time and needless expense, and lose time which, if saved, would ensure efficiency and adequate profit.

A little booklet "The Calf Path," published by Cutter, Fletcher & Company, 79 Milk Street, Boston, Mass., presents some interesting thoughts on the by-ways or calf paths of manufacture and commerce, and how they can be made smoother and more direct by the application of modern methods and expert knowledge gained from experience. It is well worth a reading, and may be had free of



charge on request from Cutter, Fletcher & Company.

INDUSTRIAL NEWS NOTES

Colonel Edwin D. Metcalf, President and Founder of the Columbian Rope Co., died at his home at Auburn, N. Y., on December 31, 1915. Everyone who came in touch with Mr. Metcalf absorbed a portion of his unbounded enthusiasm and his ability to transmit his beliefs and energy to his associates, which was, without doubt, the leading cause of the unusual success of the Columbian Rope Co., Auburn, N. Y.

Mr. Thomas B. Fournier, Chief Engineer of the Becker Milling Machine Co., Hyde Park, Boston, Mass., has severed all connections with this Company to become General Manager of the Standard Machinery Co., Mystic, Conn.

The H. W. Caldwell & Son Co., 50 Church street, N. Y., opened a sales and engineering office on January 1st, at 711 Main street, Dallas, Tex., in charge of J. C. Van Arsdell.

The Richardson-Phenix Co., Milwaukee, Wis., has recently opened an office at 141 Milk street, Boston, Mass. This office will be in charge of Mr. Charles E. Blake, who has had many years' experience in the design and installation of power plant lubricating systems.

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The Buffalo Foundry & Machine Co., Buffalo, N. Y., opened an office at 1432 Whitehall Building, 17 Battery Place, New York City, on December 1, 1915. They manufacture "Buflovak" Vacuum Apparatus, including Vacuum Dryers of all types for drying all sorts of materials, Dry Vacuum Pumps, Condensers, Vacuum Drying and Impregnating Apparatus, etc.; "Buflokast" Chemical Apparatus, including complete plants and apparatus for the manufacture of aniline, phenol, beta naphthol, picric acid, caustic soda, acids, chemicals, and kindred organic materials; "Bell" Steam Hammers. They also do a general jobbing and machine business, and can quote on castings up to 200 tons in weight each, including all necessary pattern and machine work.

The International Oxygen Co., 115 Broadway, N. Y., will inaugurate the 8-hour day at their works, Newark, N. J., after January 1, 1916.

The Richardson Scale Co., of Passaic, N. J., manufacturers of automatic weighing machinery and general sales agent for the Merrick Weightometer, will open an office after February 1st at 326-27 Omaha Grain Exchange Building, Omaha, Neb.

The organization of the Electric Steel Company marks a new and radical development in the steel castings industry of Chicago. At the present time the only electric furnace in Chicago is of the Heroult type and melts steel for large castings. The other jobbing steel foundries all operate converters. The Electric Steel Company will operate a Snyder electric furnace and will confine itself to small castings of superior quality, especially in alloy steel castings.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Bucket Conveyors

THE C. W. HUNT Co., Inc., West New Brighton, N. Y., have issued a catalogue describing in detail the Hunt Noiseless Pivoted Bucket Conveyor for handling coal, ashes, coke, phosphate rock, cement clinker, etc. This catalogue is especially interesting to those operating or designing a power house. It suggests the advantages and obvious savings possible with a properly arranged coal and ashes handling plant. Ask for catalogue G 15-4.

Insulation

THE ARMSTRONG CORK Co., Pittsburgh, Pa., have issued the last edition of the Corkboard Catalogue, entitled "Nonpareil Corkboard Insulation." This book contains much information of value to anyone interested in heat insulating materials for low and moderate temperatures.

Testing Machines

THE WATSON-STILLMAN Co., 54 Church street, New York, N. Y., have just issued catalogue No. 93, dealing with Sturcke-Watson-Stillman Testing Machines for Cylindrical Gas Containers. This is a revision of a former edition and contains much new information about testing gas containing cylinders.

Hoists

THE WRIGHT MFG. Co., 70 Woodbridge street, Detroit, Mich., have issued their 1916 catalogue describing "Wright Hoists." It contains new and interesting information in regard to hoisting machinery.

Clutches

THE THOMAS COUPLING Co., Troy, Pa., has taken over the manufacture of the Empire Friction Clutch. A booklet describing this widely used clutch has just been issued which contains much information of value to anyone interested in this line of machinery.

Making Heat Produce

THE DIAMOND POWER SPECIALTY Co., Detroit, Mich., have issued the fifth edition of "Making Heat Produce." The newest edition is pocket size and its fourteen pages contain information that is of much interest and value to every one having to do with the care and operation of boilers. This book is not an advertisement for Diamond Soot Blowers but was written by Dr. S. J. Herman an authority on combustion problems. His statements are not theoretical but are based on facts. The tests he shows are exceedingly interesting and one of them was made by Prof. A. J. Moyer, formerly Professor of Mechanical Engineering at Penn. State College.

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IMPROVED MACHINERY

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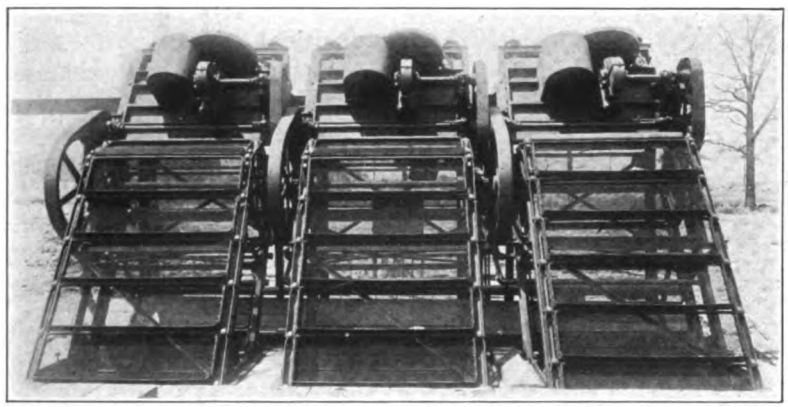
A PRACTICAL SELF CLEANING WATER SCREEN

THE necessity for clean circulating boiler water has become an accepted fact. Ever since the introduction of condensers, there have been devices for screening water and removing at least the larger pieces of foreign matter.

Every engineer is familiar with the fact that no matter how many slid-

years ago the Chain Belt Company, at the request of Messrs. Sargent & Lundy, Chicago, Consulting Engineers, built three machines known as the "Chain Belt Self Cleaning Traveling Water Screens." These were installed at the Northwest plant of the Commonwealth Edison Company in Chicago.



ing screens are placed in an intake, one after the other when each screen is raised, a certain amount of sediment drops down and passes under and onto the next one. This process repeats itself until the last screen is raised and then the droppings enter the intake to the power plant and are carried into the pumps and condenser tubes where they hasten the necessity for cleaning these auxiliaries.

It was with the view of improving the conditions outlined that a few

The screens shown in the illustrations are in operation today and have been ever since their installation. The success with which they operate is proved by the fact that a year or two after the original installation three more screens were installed in the same company's Fisk Street Plant. Just recently four more units have been installed in the Northwest Plant, making a total of ten screen units for this company.

The general principle on which the

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screens are built is very ingenious, and the early experience of the Chain Belt Company enabled them to make many improvements, so that the screens built at present are quite different from the original installations.

The machines consist essentially of wire screening baskets mounted on two strands of steel chain belt. These chain belts and screens form a continuous screening apron which passes over sprockets at the top and bottom of the device, the sprockets being mounted on a structural steel supporting frame.

The cleaning of the screen baskets after they pass over the head sprockets is effected by having a spray running back of the screen baskets, which enables a continuous spray of water to pass through the screens from the back to the front, thus carrying away the particles which would naturally adhere to the screens.

In the majority of installations these screens have been placed on an incline as shown on the illustration, but there are several units which have been built in a vertical position and which operate with entire satisfaction. A notable installation of this kind is in the Commerce Street Plant of the Milwaukee Electric Railway & Light Co., Milwaukee, Wis.

The Chain Belt Company has not only developed and perfected the mechanical design of the traveling screens but has accumulated an amount of valuable data which enables its engineering department to make recommendations to power plant engineers as to the proper size and arrangement of screens most suitable for their conditions.

The Chain Belt Company, Milwaukee, Wis., will furnish further information and literature upon request.

A Small Reliable Turbo-Generator

THE Kerr Turbine Co., Wellsville, N. Y., has standardized a line of small direct connected D. C. turbo-generators, in sizes from 5 K.W. to 50 K.W. for both 125 volt and 250 volt current, whose compactness, simplicity of construction and operation and reliability in service has resulted in their installation in great numbers. The general appearance of these neat little units is evident from the illustration.

Some of the applications in which these generating units have found a ready market are in connection with locomotive cranes and lifting magnets, on board lake, river and ocean steamers, for providing excitation current for larger alternators, and for carrying the very light load frequently characteristic of the load curve of small electric light plants. Wherever small quantities of power are required, these "Kerr-Economy" direct

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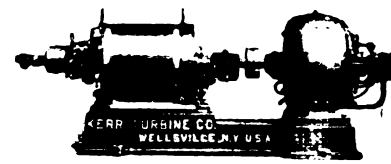
connected sets offer a relatively inexpensive, extremely simple solution of the problem, and will generate the power at rates of steam consumption which compare very favorably with far more complicated and expensive types of generating apparatus.

The steam end of these units in the smallest sizes, consists of the well-known multi-pressure stage "Kerr-Economy" turbine and embodies all the principles and structural features employed in the Kerr Turbine Company's larger machines. The generators are stocked and usually very



prompt shipments can be made on units adapted for any ordinary steam pressures.

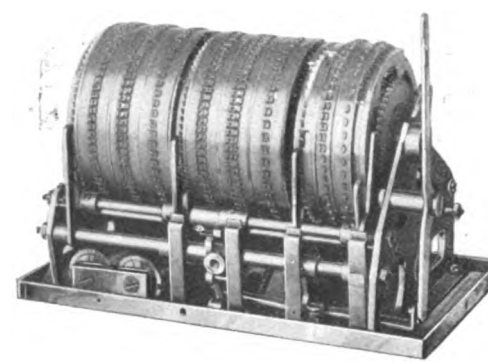
COMPUTING ELAPSED TIME, LABOR AND OVERHEAD, MECHANICALLY

THE final step in automatic cost accounting seems to have been attained in a new device called the "Ficker Cost Recorder." This machine is practically a time and cost accounting department in itself. It records the time an employee arrives in the morning, the time he goes out and comes in at noon and the time he leaves at night. The starting and finishing time of each job to which the workman is assigned during the day is recorded and the machine automatically computes the elapsed time, labor and overhead expense incurred on every job. It also records cumulative totals for the elapsed time, labor and overhead expenses for all the jobs a man has worked on during the day and automatically eliminates lunch periods of any duration.

All records made by the "Ficker Cost Recorder" are printed in clear type in a straight line. These machines automatically reset themselves each day and require no winding or adjusting.

A master clock, which makes and breaks an electric circuit once every minute allows the electric current to operate a small electro-magnet in each recorder, and provides the motive means by which these machines are operated. Either alternating or direct current can be used and the amount consumed is negligible.

One of these recorders is installed at each workman's bench and all time



heretofore wasted in reporting to time clerks is eliminated. In and out clocks are also eliminated because each employee records his in and out time at his bench. The recorders are not sold but are rented at a surprisingly low price by the year. The total outlay involved is considerably under that of obtaining the same results by any other mechanical or clerical means, and the resultant saving in even a small factory makes it worthy of careful investigation. The Ficker Recording Machine Co. of No. 17 Battery Place, N. Y., will be glad to furnish further information upon request.

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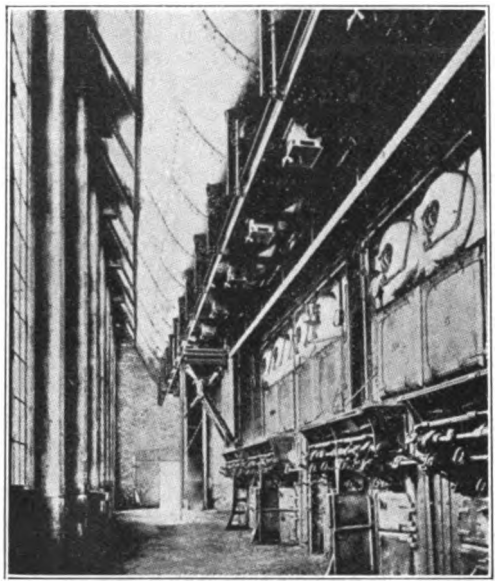
FLOOR OPERATED LARRIES FOR SERVING BOILERS

THE day of the individual chute from coal bunker to stoker, or even to firing aisle, if boilers are hand fired, is rapidly passing. Its work is being done better and more efficiently by the larry. This machine consists of a hopper mounted on scale beams, the scale framework



forming part of a truck having wheels which travel on a track, under and parallel with the bunker. Coal is let into the hopper from the bunker, and, after being weighed, is allowed to flow into the stoker magazine through a chute extending from the hopper.

Types of larries range all the way from the small hand propelled floor operated ones to those of large capacity, propelled by motors and operated from a cage which is part of the larry framework.

The illustration shows one of the former type as designed and installed in the boiler room of the American Optical Co. at Southbridge, Mass., by the R. H. Beaumont Company of Philadelphia.

The best feature of larries is the fact that bunker outlets can be spaced close together and at a uniform distance apart throughout, because bunker gate spacing does not depend upon boiler setting as is the case where chutes are used. It will be readily seen that this leaves a minimum quantity of dead coal between the gates.

Another feature is that the larry is fitted with a scale and an accurate record of each boiler's consumption can be kept. This is not left to the memory of the operator because the scale is fitted with an automatic ticket recorder. What plant manager knows which of his boilers is doing more than its share in eating up that coal pile? It is almost certain that he who employs stationary chutes does not know.

Wherever chutes are used, and for any reason a boiler is out of order, all coal in the bunker opposite that boiler is absolutely useless. With a larry, this coal can be drawn off and fed to the other boilers anywhere in the house. The firing aisles are kept comparatively clear of stationary structures enabling an easy removal of tubes, or opening of boilers for washing or repairing. The most important argument for the floor-operated larry as shown in the illustration is its ease of operation. The operator has four distinct things to do:—(a) Move larry; (b) Open bunker gates; (c) Weigh coal; (d) Discharge to stokers. The attendant's position with relation to the larry is always the same. This naturally makes for efficiency.

This machine has been successfully developed by the R. H. Beaumont Company, Engineers and Contractors, 426 Chestnut Street, Philadelphia, Pa., who would be pleased to receive inquiries from those interested for more detailed or specific information.

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A Calorimeter Equipped With a Jacket

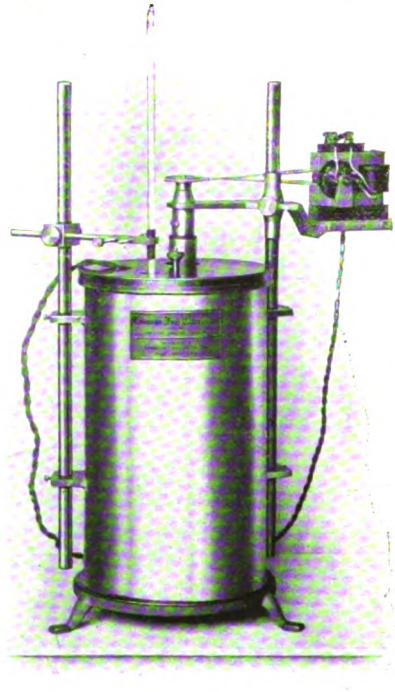
THE accompanying illustration shows the new design of Emerson Calorimeter equipped with a vacuum walled cup as an insulating jacket.

A calorimetric test is always made under ideal conditions when the calorimeter bucket is surrounded with suitable heat insulating material or under conditions, such that there will be a minimum exchange of heat between the bucket and its surroundings. A vacuum wall furnishes, as is well known, an almost perfect heat insulating medium.

By means of this vacuum cup, the radiations to and from the calorimeter water are minimized to such an extent that at the time of a heat of combustion determination in the calorimeter, the heat reaction is carried out under conditions where no appreciable amount of heat is lost from or added to the calorimeter water.

In addition to the increased accuracy, there is the further important point that it eliminates the customary cooling correction, which has to be taken into account with the ordinary types of calorimeter jacket.

Further details of the calorimeter are given in the new instructions pamphlet of the Emerson Fuel Calorimeters, which may be obtained from the Emerson Apparatus Co., 251 Causeway St., Boston, Mass.



An Effective Friction Clutch for Gas Engines

IT is beyond doubt that gas engine power is the most severe to which any clutch can be subjected, and it is in this special service that the Thomas-Empire Friction Clutch has demonstrated that it transmits this jerky impulsive power with ease and satisfaction. In every case involving unsteady power, intermittent impulses or shocks, such as will always be found in gas engine service, ample allowance must be made to meet the maximum inertia load by an increase in size of clutch.

Inertia loads are of the following

FRONT VIEW. EMPIRE FRICTION CLUTCH

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nature: starting heavy flywheels, armatures, highspeed machinery, etc., or machinery that must be started under full load in a clogged condition, such as circular and band saws, grinding machinery, etc., all of which must be started from a state of rest.

The Empire Friction Clutch is compact, durable and powerful in its grip, neat and attractive in its design as shown in the illustration. It is made with two or four arms as the necessity of the case may require, and yet so simple in construction that it can be placed on the market at a price to meet the demand of the most economical manufacturer. There are at present, thirty thousand of these clutches in actual operation, fifteen thousand of which are in use on gas engines.

Further information concerning this clutch can be obtained from The Thomas Coupling Co., Troy, Pa.,

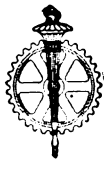
A New Automatic Time Recording Machine

IT has been demonstrated time and again that employees cannot be relied upon to enter their own time; they forget, they make errors, and even intentional "mistakes" creep in.

A new automatic time recording machine has been put on the market by the Automatic Time Stamp Co. which has gone far toward the solution of the time cost keeping problem. This machine is called the "Duragraph" and is an accurate mechanical time printing machine, especially designed to record the "beginning," "finishing" and "elapsed time" in the simplest possible manner, upon a suitable ticket or card.

The operation of the "Duragraph" is very simple, the time tickets being merely dropped into the pocket at the top of the machine and the imprinting lever or handle at the bottom being then depressed, the ticket is first automatically placed in the proper position and immediately afterwards the date—if required—and the clock hand are printed, the latter in the proper relation to the graduated dial, thus recording and indicating the "beginning" or "finishing" time as the case may be, the "elapsed time" relating to any job appearing upon the clock dial imprint between the imprints of the two clock hands.

If desired the "Duragraph" clock may be arranged to be electrically operated or controlled in connection with a master clock, so that any number of these machines will keep the same time. Further information will be gladly furnished by the Automatic Time Stamp Co., 163 Congress St., Boston, Mass.



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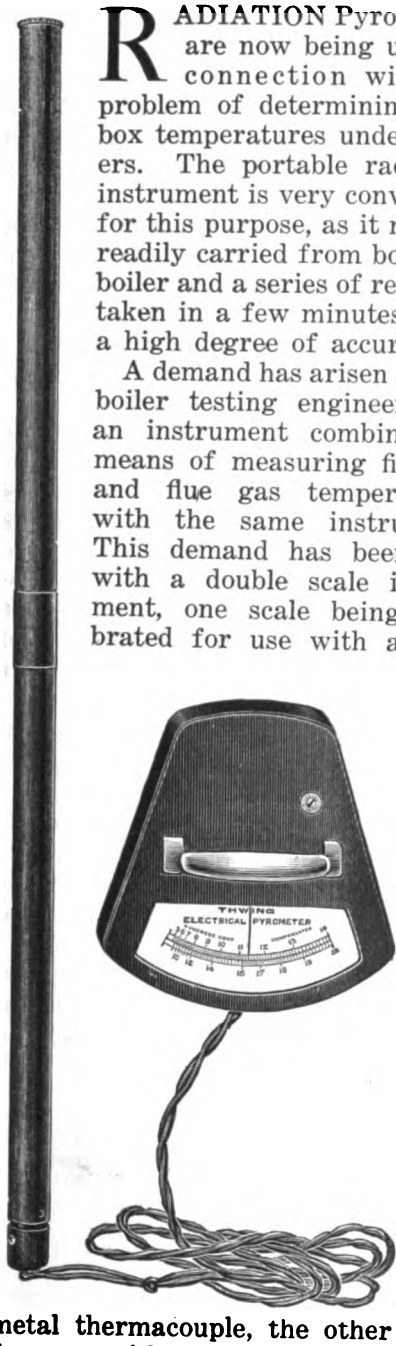
A Convenient Radiation Pyrometer for Boiler Plants



RADIATION Pyrometers are now being used in connection with the problem of determining fire-box temperatures under boilers. The portable radiation instrument is very convenient for this purpose, as it may be readily carried from boiler to boiler and a series of readings taken in a few minutes, with a high degree of accuracy.

A demand has arisen among boiler testing engineers for an instrument combining a means of measuring fire-box and flue gas temperatures with the same instrument. This demand has been met with a double scale instrument, one scale being calibrated for use with a base metal thermacouple, the other scale for use with a radiation receiving tube.

The advantage of this instrument is that the heat losses in the boiler plant can be located. Thus a great saving in the fuel bill, and wasteful conditions are reduced to a minimum.

Further information and literature will be gladly furnished upon request by The Thwing Instrument Co., 496 Noble Street, Philadelphia, Pa.

PERSONAL NOTES

Mr. E. C. Waldvogel, who has been connected with the Yale & Towne Mfg. Co., 9 East 40th Street, New York, has just been appointed General Manager. In addition to the regular duties belonging to his new office, Mr. Waldvogel will have general supervision of all sales: Domestic, Canadian and Export.

Mr. John A. Bookwalter was elected President of the James Leffel & Co. at a recent meeting of the directors. He was chosen to fill the vacancy caused by the death of his uncle, John W. Bookwalter. Mr. Bookwalter has been Vice President and Treasurer of the Company for a number of years.

Mr. Maynard D. Church has recently been appointed Chief Engineer of the Terry Steam Turbine Co., Hartford, Conn.

Mr. Alexander Saunders, President of D. Saunders Sons, Inc., died at his home, 260 Warburton Avenue, Yonkers, N. Y., on February 1, 1916.

Mr. C. G. Elliott, C. E., of Washington, D. C., who was for ten years Chief Drainage Engineer of the U. S. Department of Agriculture, has become affiliated with the corporation which will hereafter be known as the Elliott and Harman Engineering Co., 144 Fredonia Avenue, Peoria, Ill.

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INDUSTRIAL NEWS NOTES

The Bristol Company have just established a new branch office at 727 Rialto Bldg., San Francisco, Cal. Mr. B. J. Klein, a mechanical engineer and instrument expert, who has had long experience with the Bristol Company, has been appointed Pacific District Manager and will have his headquarters at this new Branch Office.

Kelly, Cooke & Co. have recently opened offices in the Drexel Building, Philadelphia, Pa., to conduct a general engineering practice in the public utility and industrial fields. Their organization is equipped for the design and supervision of construction for railways, light and power properties and industrial plants; engineering reports, appraisals and rate developments for public utilities. The firm also investigates industrial situations to develop ways and means for reducing manufacturing costs.

In the third paragraph of the article on Heræus Resistance Thermometers, which appeared in the Improved Machinery Section of the February number of THE ENGINEERING MAGAZINE, the first mentioned temperature should read as follows: minus (—) 373°.

In view of the increase in the sales of Steam Traps SARCO and Temperature Regulators SARCO, which have broken all records during 1915, a new company entitled the SARCO COMPANY, INC., has been formed by the Sarco Engineering Company and the Roller-Smith Company of New York City and Bethlehem, Pa.

The Sarco Company, Inc., which will handle all sales, will control greatly increased selling and manufacturing facilities. It started operations on January 1st and its address will be South Ferry Building, New York City.

It is announced that the American Coal Products Company, well known in connection with the sale of sulphate of ammonia, and parent organization of the widely known Barrett Manufacturing Company, has decided to unite the good-will and high reputation of both concerns under the name of "The Barrett Company."

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Bearings

THE NORMA COMPANY OF AMERICA, 1790 Broadway, New York, have issued their new catalogue entitled "Norma" Precision Bearings. It is a pamphlet of exceptional scope and completeness, giving information that is especially interesting to draughtsmen and designing engineers.

Illumination

THE WESTERN ELECTRIC COMPANY, INC., Chicago, Ill., have just issued the sixth edition of "How to Figure Illumination," which is a complete catalogue of "Sunbeam Mazda Lamps." This booklet gives tables and illuminating data, as well as picturing and describing the various sizes of Sunbeam Mazda Lamps. By means of the information presented, anyone can readily lay out lighting installations adapted to the requirements of any class of lighting. A copy of this booklet will be mailed to anyone upon request.

Wagon Loaders

THE LINK-BELT CO., 39th St. and Stewart Ave., Chicago, Ill., has issued their new wagon and truck loader catalogue No. 250, which gives illustrations, descriptions, specifications and net prices of all standard Link-Belt portable wagon loaders.

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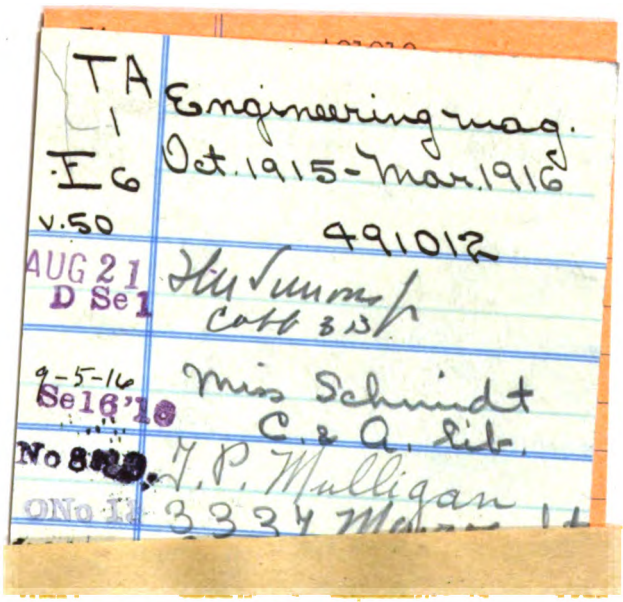

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